APPROVED FOR RELEASE
DATE: MAY 2006

COPY NO. 15

TDC NO. 11

10 May 1968

(b)(1)
(b)(3)

TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 UTILITY FLIGHT MANUAL DATED 16 March 1968

OXC-0433-68
COPY 3 OF 5

SECTION	PAGE	CHANGE
		This TDC changes normal operation procedure for Descent and Engine Shutdown.
II	2-21	Insert page 2-20A.
II	2-31	Insert page 2-30A
		The Abbreviated Checklist will be changed and replacing pages furnished.

NOTE : **The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.**

NORMAL DESCENTS - Change to read as follows:

At Mach 1.5:

13. RPM - Check 6000 or above.

Maintain at least 5500 during remainder of descent to subsonic speed.

ENGINE SHUTDOWN - Change as follows:

CAUTION (same)

1. Wheel chocks - Installed (same)

2. Canopy seal pressure lever - OFF

3. Canopy - Open

4. INS - As briefed.

CAUTION

The INS should not be operated more than 5 minutes after opening the canopy to avoid the possibility of excessive INS component temperatures.

Balance of step procedure same.

COPY NO. 15

TDC No. 9
16 March 1968

OXC-03668
COPY 3 OF 4

A-12 FLIGHT MANUAL

TECHNICAL DATA CHANGE

This TDC transmits revised pages which replace and supersede previously furnished pages for the Flight Manual dated 15 October 1967. Incorporation of previously furnished TDC's provides expanded performance which includes:

Revised Military Climb performance at various temperatures (1956 ARDC Atmosphere).

Revised Normal Climb performance at various temperatures for both 1956 ARDC and "Mean Tropic" Atmospheres.

Revised Cruise performance at various temperatures.

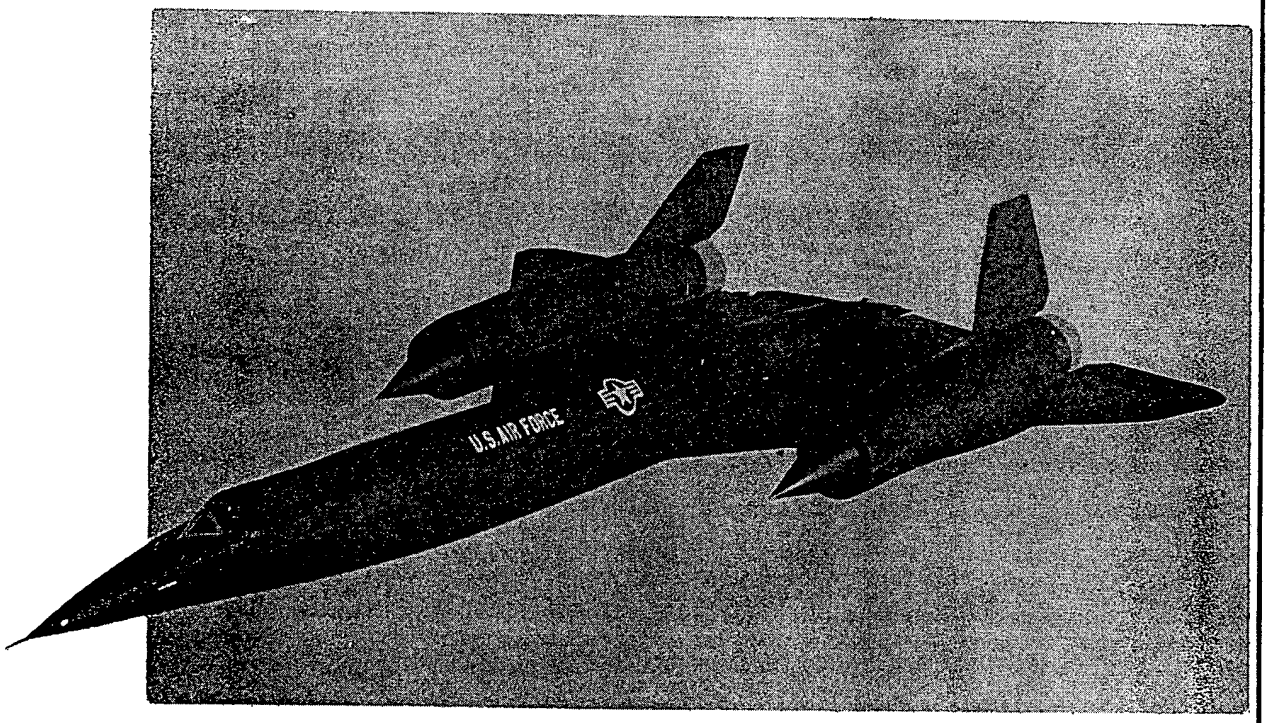
Revised Cruise Profiles covering:

- Long Range Cruise
- High Altitude Cruise
- Maximum A/B Ceiling Cruise

Additional descriptive and operating information has been incorporated including Emergency forward transfer, updated engine time, EGT limits, additional tire limits and a new drag chute deploy limits. The Pilot's Abbreviated Checklist will be revised and issued to conform.

COPY NO. 15

A-12



UTILITY FLIGHT MANUAL

15 SEPTEMBER 1965

CHANGED 15 JUNE 1968

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TECHNICAL DATA CHANGE SUMMARY

TDC	Date	Purpose	Status
No. 1	10-16-67	Est. Tropical Atmosphere Climb Performance	Superseded by TDC 3
No. 2	1-26-68	Emergency Forward Transfer	Inc.
No. 3	2-05-68	Revised Climb and Cruise Performance (1956 ARDC Atmosphere & "MEAN TROPIC" Atmosphere)	Inc.
No. 4A	3-04-68	Time Limits & EGT Limits	Inc.
No. 5	3-01-68	Supersonic Cruise Flight Characteristics	Inc.
No. 6	3-05-68	Tire Limits	Inc.
No. 7	3-06-68	Climb and Cruise Performance	Inc.
No. 8	3-15-68	Increase Chute Deploy Limit 210 KIAS	Inc.
No. 9	3-16-68	Transmit Printed Change Dated 3-15-68	Inc.
No. 10	5-7-68	Rapid Deployment to ARCP	Inc.
No. 11	5-10-68	Normal Operation for Descent & Engine Shutdown	Inc.
No. 12	5-16-68	Normal Climb Performance Revised	Inc.
No. 13	6-15-68	Transmit Printed Change Dated 6-15-68	Inc.

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OXC-0533-68
COPY 3 OF 4

TDC No. 13
15 June 1968

A-12 FLIGHT MANUAL

TECHNICAL DATA CHANGE

This TDC transmits revised pages which supersede previously furnished pages for the Flight Manual dated 15 October 1967. All previously issued TDC's are incorporated.

In addition, this TDC includes:

a. Rapid Deployment to ARCP data.

b. Revised presentation of normal climb performance

c. Revised presentation of cruise performance for long range and high altitude cruise (1956 ARDC and "MEAN TROPIC" atmospheres)

d. Revised single engine descent data for various speeds, powers, and for both 1956 ARDC and "Mean Tropic" atmospheres.

e. Minor descriptive material.

Previously issued checklist changes conform with procedures supplied in this manual.

RETURN TO ARCHIVES & RECORDS CENTER
IMMEDIATELY AFTER USE
JOB 81B00881 BOX 7

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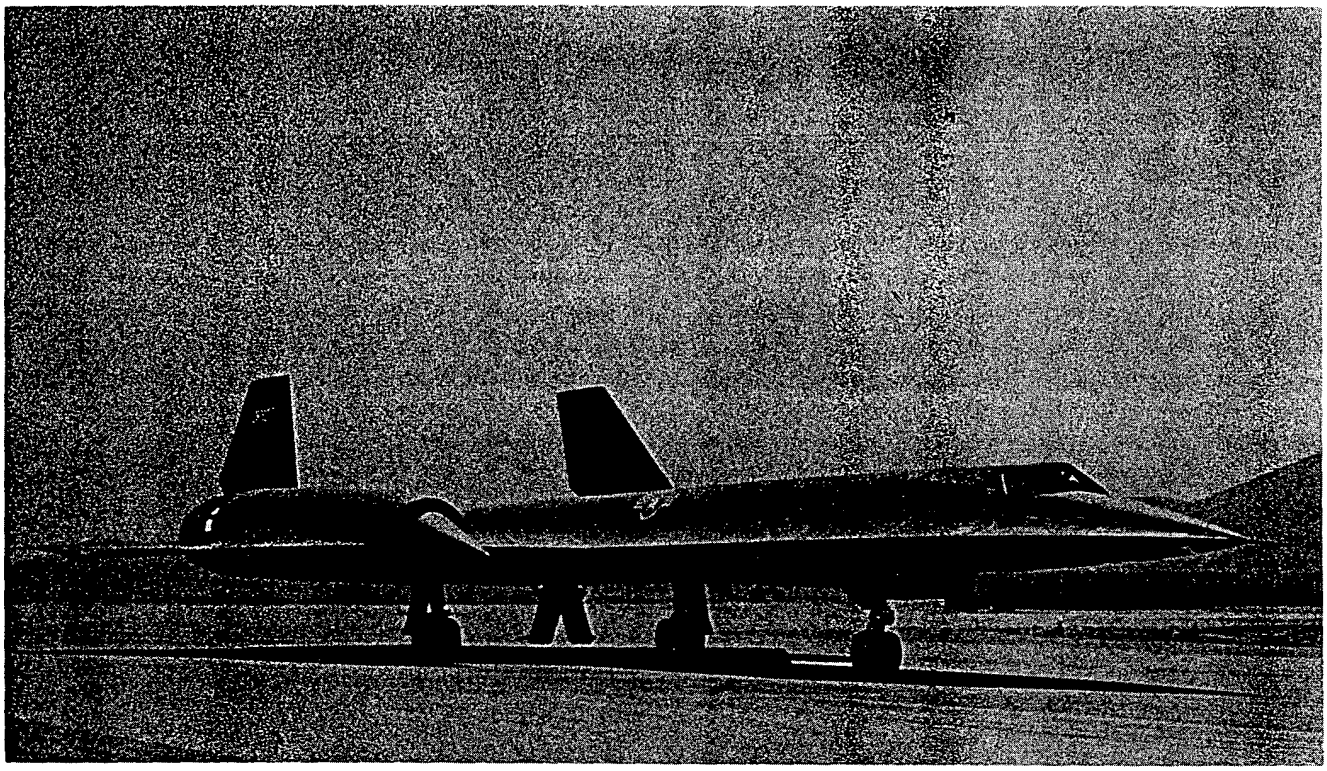
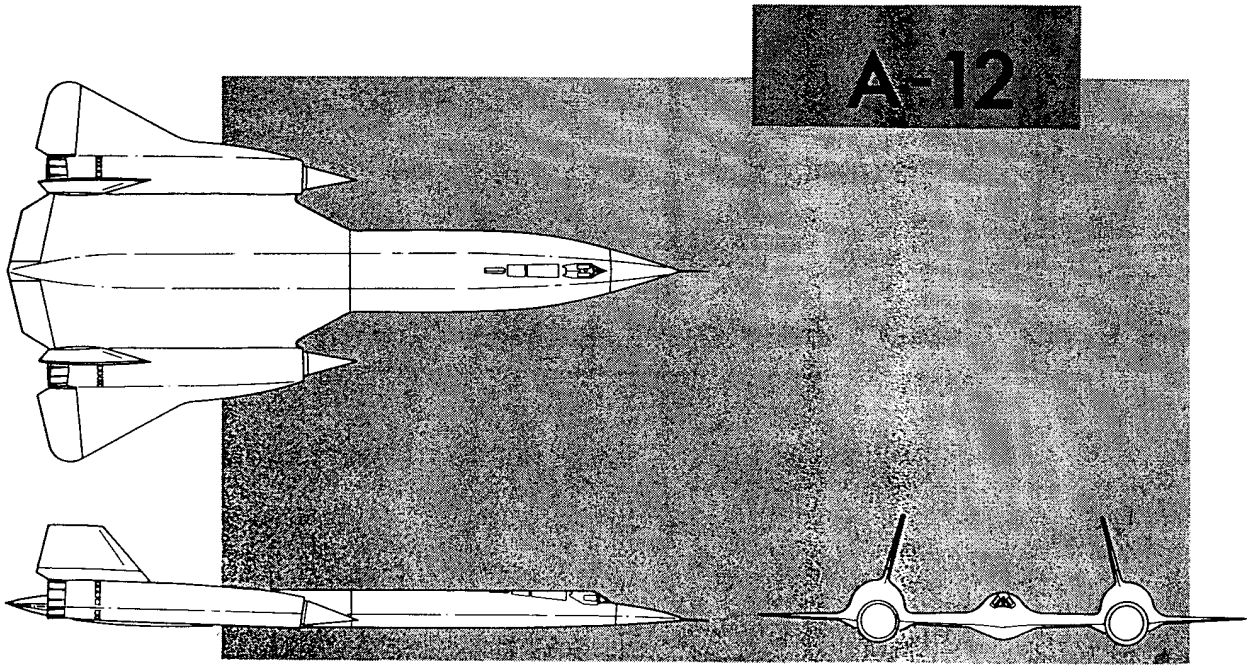
Appendix:	Performance Data	A-1





4-26-66
F200-30

DESCRIPTION

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THE AIRCRAFT

The A-12 is a delta wing, single place aircraft powered by two axial flow bleed bypass turbojet engines with afterburners. The aircraft is built by the Lockheed-California Company and is designed to operate at very high altitudes and at high supersonic speeds. Some notable features of the aircraft are very thin delta wings, twin canted rudders mounted on the top of the engine nacelles, and a pronounced fuselage chine extending from the nose to the leading edge of the wing. The propulsion system uses movable spikes to vary inlet geometry. The surface controls are elevons and rudders, operated by irreversible actuators with artificial pilot control feel. A single-point pressure refueling system is installed for ground and in-flight refueling. A drag chute is provided to reduce landing roll.

AIRCRAFT DIMENSIONS

The overall aircraft dimensions are as follows:

Wing Span	55.62 ft.
Length (overall)	101.6 ft.
Height (to top of vertical stabilizer)	18.45 ft.
Tread (MLG center wheels)	16.67 ft.

AIRCRAFT GROSS WEIGHT

The ramp gross weights of these aircraft may vary from approximately 122,900 lb. to 124,600 lb. with 10,590 gallons of fuel. This is based on zero fuel weights between 54,600 lb. and 56,300 lb., fuel density of 6.45 lb. per gallon, and varying equipment loading configurations.

GENERAL ARRANGEMENT

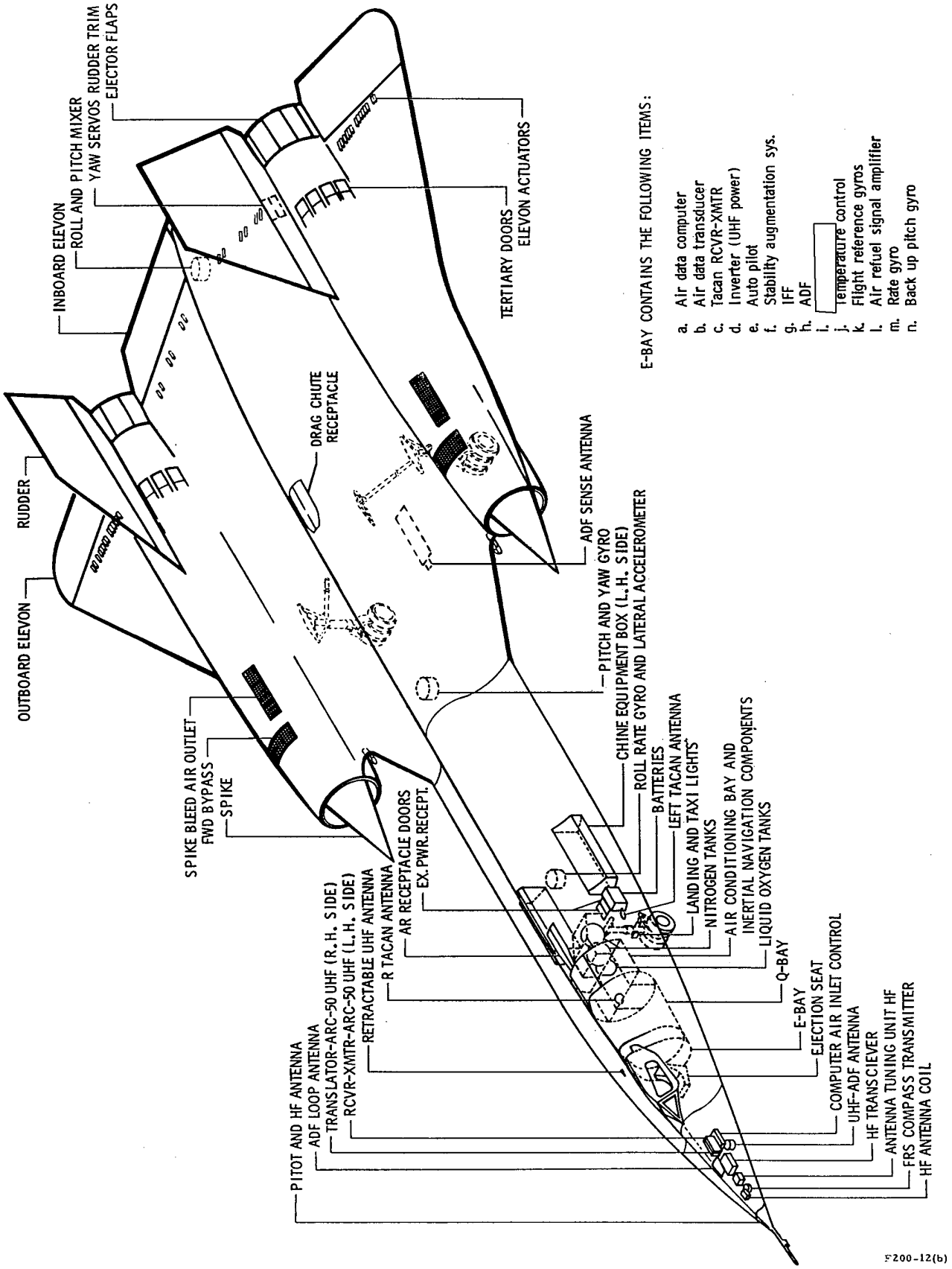
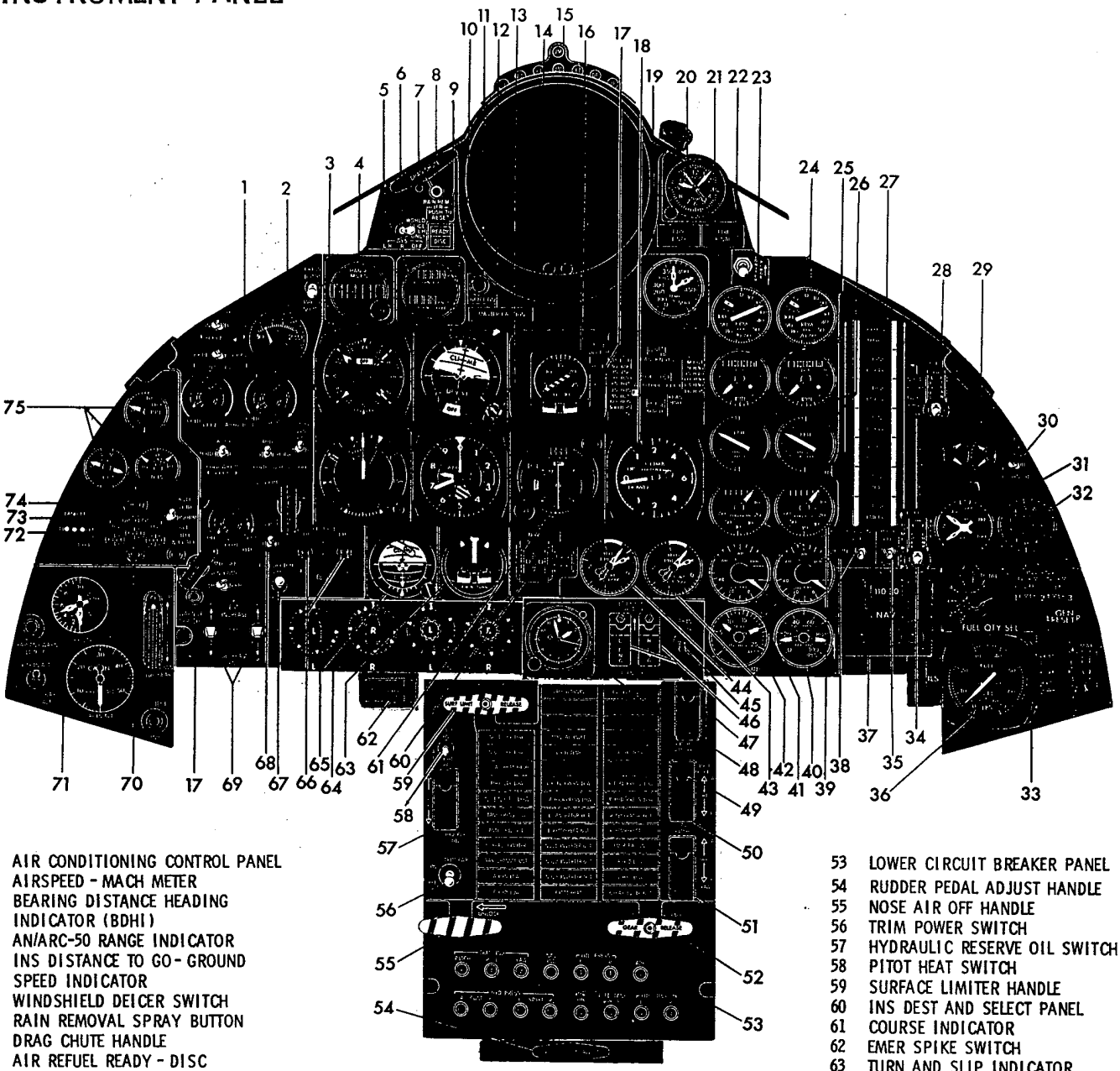


Figure 1-1

INSTRUMENT PANEL

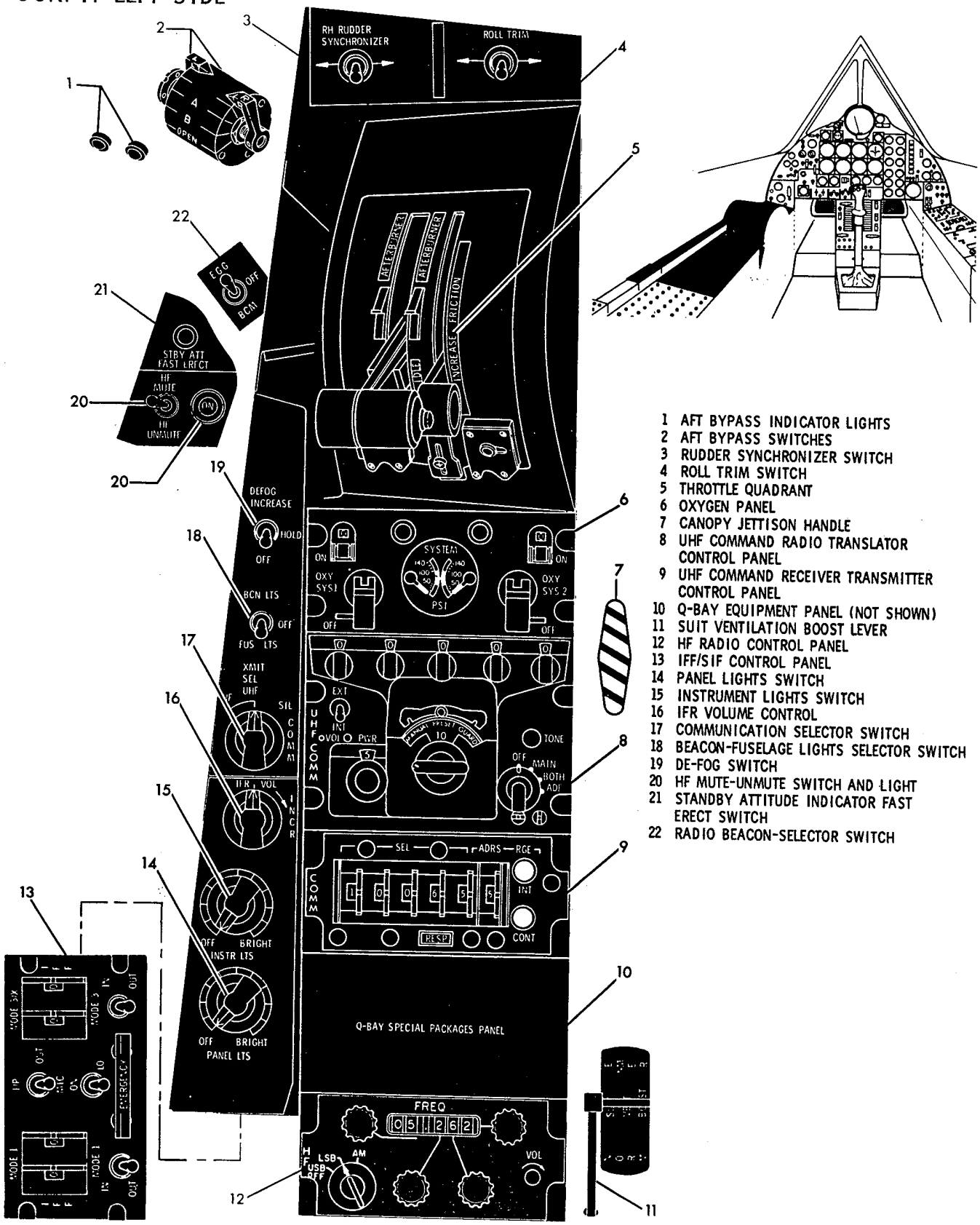


1 AIR CONDITIONING CONTROL PANEL
2 AIRSPEED - MACH METER
3 BEARING DISTANCE HEADING INDICATOR (BDHI)
4 AN/ARC-50 RANGE INDICATOR
5 INS DISTANCE TO GO - GROUND SPEED INDICATOR
6 WINDSHIELD DEICER SWITCH
7 RAIN REMOVAL SPRAY BUTTON
8 DRAG CHUTE HANDLE
9 AIR REFUEL READY - DISC LIGHT AND SWITCH
10 ATTITUDE INDICATOR
11 DE-ICING WARNING LIGHT
12 MASTER CAUTION LIGHT
13 ALTIMETER
14 PERISCOPE VIEWING SCREEN
15 [redacted] LIGHTS
16 COMPRESSOR INLET STATIC PRESSURE GAGE
17 FUEL DERICHMENT WARNING LIGHTS (2)
18 VERTICAL SPEED INDICATOR
19 COMPRESSOR INLET TEMPERATURE GAGE
20 ELAPSED TIME CLOCK
21 FIRE WARNING LIGHTS
22 TRIPLE DISPLAY INDICATOR
23 IGNITER PURGE SWITCH
24 TACHOMETERS
25 EXHAUST GAS TEMPERATURE INDICATORS
26 EXHAUST NOZZLE POSITION INDICATORS
27 FUEL TANK SWITCHES
28 FUEL FORWARD TRANSFER SWITCH
29 QUAD HYDRAULIC QUANTITY
30 AIR REFUEL SWITCH
31 LIQUID NITROGEN QTY INDICATOR
32 FUEL TANK PRESSURE INDICATOR
33 RIGHT FORWARD PANEL
34 FUEL DUMP SWITCH
35 PUMP RELEASE SWITCH
36 FUEL QUANTITY INDICATOR
37 ILS PANEL
38 TEST N AND TANK LIGHT SWITCH
39 FUEL FLOW INDICATORS
40 FWD BYPASS POSITION INDICATOR
41 OIL PRESSURE INDICATORS
42 SPIKE POSITION INDICATOR
43 HYDRAULIC SYSTEM (A AND B) PRESSURE GAGE
44 HYDRAULIC SYSTEM (L AND R) PRESSURE GAGE
45 COCKPIT PRESSURE SCHEDULE SWITCH
46 EMERGENCY FUEL SHUTOFF SWITCHES
47 BACKUP PITCH DAMPER SWITCH
48 A-13A CLOCK
49 ANNUNCIATOR PANELS
50 PITCH LOGIC OVERRIDE SWITCH
51 YAW LOGIC OVERRIDE SWITCH
52 LANDING GEAR RELEASE HANDLE
53 LOWER CIRCUIT BREAKER PANEL
54 RUDDER PEDAL ADJUST HANDLE
55 NOSE AIR OFF HANDLE
56 TRIM POWER SWITCH
57 HYDRAULIC RESERVE OIL SWITCH
58 PITOT HEAT SWITCH
59 SURFACE LIMITER HANDLE
60 INS DEST AND SELECT PANEL
61 COURSE INDICATOR
62 EMER SPIKE SWITCH
63 TURN AND SLIP INDICATOR
64 SPIKE AND BYPASS CONTROL PANEL
65 STANDBY ATTITUDE INDICATOR
66 RESTART SWITCHES
67 FUEL DERICHMENT ARMING SWITCH
68 PERISCOPE CONTROL PANEL
69 EXHAUST GAS TEMPERATURE TRIM SWITCHES
70 LANDING GEAR DOWN INDICATOR LIGHTS
71 LEFT FORWARD PANEL
72 LANDING AND TAXI LIGHT SWITCH
73 ALT STEER AND BRAKE SWITCH
74 LANDING GEAR WARNING CUTOUT BUTTON
75 PITCH-ROLL-YAW TRIM INDICATORS

F200-14(i)

Figure 1-2

COCKPIT LEFT SIDE

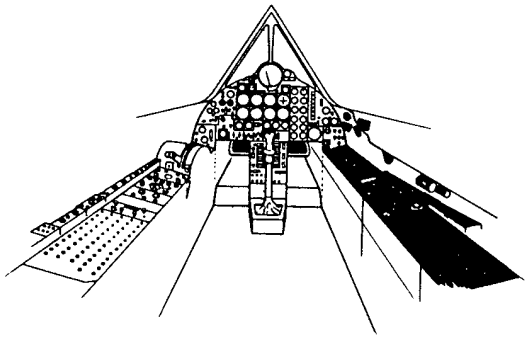


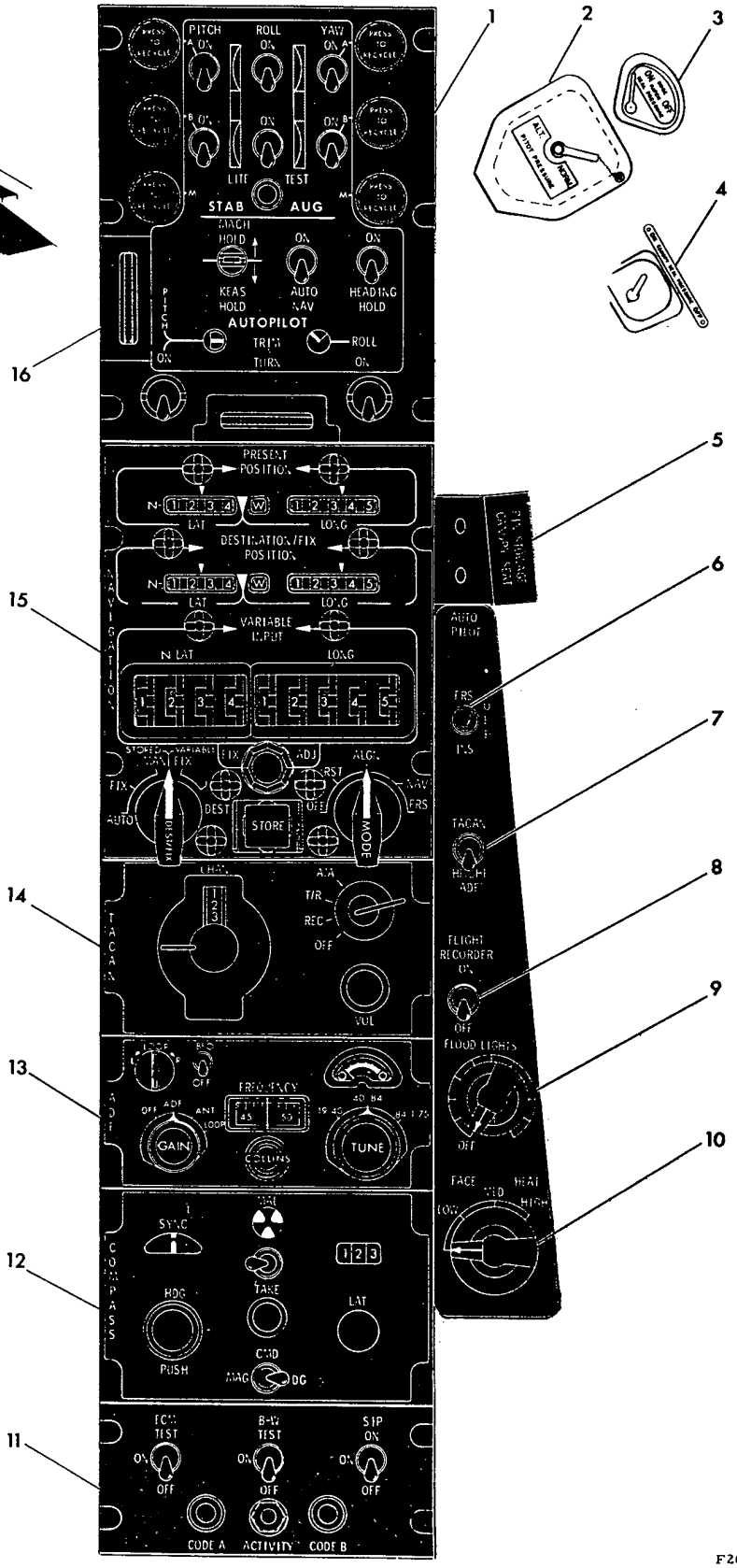
1 AFT BYPASS INDICATOR LIGHTS
2 AFT BYPASS SWITCHES
3 RUDDER SYNCHRONIZER SWITCH
4 ROLL TRIM SWITCH
5 THROTTLE QUADRANT
6 OXYGEN PANEL
7 CANOPY JETTISON HANDLE
8 UHF COMMAND RADIO TRANSLATOR CONTROL PANEL
9 UHF COMMAND RECEIVER TRANSMITTER CONTROL PANEL
10 Q-BAY EQUIPMENT PANEL (NOT SHOWN)
11 SUIT VENTILATION BOOST LEVER
12 HF RADIO CONTROL PANEL
13 IFF/SIF CONTROL PANEL
14 PANEL LIGHTS SWITCH
15 INSTRUMENT LIGHTS SWITCH
16 IFR VOLUME CONTROL
17 COMMUNICATION SELECTOR SWITCH
18 BEACON-FUSELAGE LIGHTS SELECTOR SWITCH
19 DE-FOG SWITCH
20 HF MUTE-UNMUTE SWITCH AND LIGHT
21 STANDBY ATTITUDE INDICATOR FAST ERECT SWITCH
22 RADIO BEACON-SELECTOR SWITCH

F200-17(f)

Figure 1-3

COCKPIT RIGHT SIDE





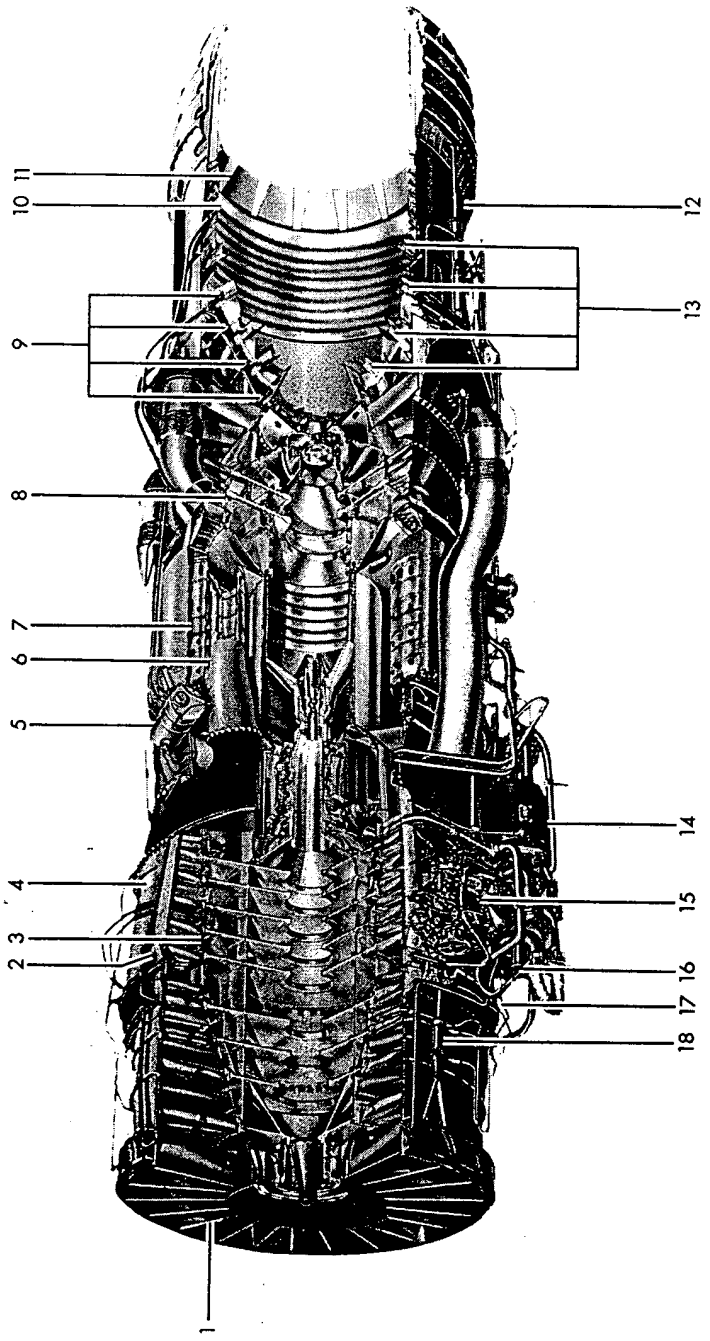
1. SAS CONTROL PANEL
2. PITOT PRESSURE SELECTOR LEVER
3. NOSE HATCH SEAL LEVER
4. CANOPY SEAL LEVER
5. SEAT AND CANOPY SAFETY PIN STOWAGE
6. AUTO PILOT SELECTOR SWITCH
7. BDHI NO. 1 NEEDLE SELECTOR SWITCH
8. FLIGHT RECORDER SWITCH
9. FLOOD LIGHT SWITCH
10. FACE PLATE HEAT SWITCH
11. [ ] AND SIP CONTROL PANEL
12. FRS CONTROL PANEL
13. ADF RECEIVER CONTROL PANEL
14. TACAN CONTROL PANEL
15. INS CONTROL PANEL
16. AUTO PILOT CONTROL PANEL

F200-18(1)

Figure 1-4

SECTION I

JT 11D-20 ENGINE


1 AIR INTAKE
2 BLEED BYPASS VALVES
3 9-STAGE COMPRESSOR SECTION
4 STARTING BLEED VALVES
5 CHEMICAL IGNITION (TEB) RESERVOIR
6 BLEED BYPASS TUBES (6)
7 BURNER CANS (8)
8 2-STAGE TURBINE
9 SPRAY BARS (4)
10 AFTERBURNER LINER
11 VARIABLE AREA EXHAUST NOZZLE
12 EXHAUST NOZZLE ACTUATORS (4)
13 FLAME HOLDERS (4)
14 MAIN ENGINE GEARBOX
15 ENGINE FUEL CONTROL
16 REMOTE GEARBOX SHAFT FITTING
17 AFTERBURNER FUEL CONTROL (RIGHT SIDE HIDDEN)
18 BLEED BYPASS VALVES ACTUATOR CYLINDERS (4)

1-29-65
FMA12-39

Figure 1-5

NOTE

See the weight and balance handbook, T.O. 1-1B-40 for information regarding specific aircraft and equipment configurations.

ENGINE AND AFTERBURNER

Thrust is supplied by two Pratt and Whitney JT11D-20A bleed bypass turbojet engines with afterburners. The interim maximum afterburning static thrust rating of each engine is 31,500 pounds at sea level with standard day conditions. The engines are designed for continuous maximum thrust operation at the high compressor inlet temperatures associated with high Mach number and high altitude operation. There is no time limit on maximum thrust operation. The engine has a single rotor, nine stage, 8:1 pressure ratio compressor utilizing a compressor bleed bypass cycle for high Mach number operation. The bypass system bleeds air from the fourth stage of the compressor, and six external tubes duct the air around the rear stages of the combustion section and the turbine. The air reenters the turbine exhaust ahead of the afterburner and is used for increased thrust augmentation. When the engine goes into bypass operation, the afterburner fuel control resets to furnish additional fuel to the afterburner. The transition to bypass operation is scheduled by the main fuel control as a function of compressor inlet temperature (CIT) and engine speed. The transition normally occurs at a CIT of approximately 150° to 190°C, corresponding to a Mach number range of 2.2 to 2.3.

Engine speed on the ground, or at low Mach numbers, varies with throttle movement from IDLE to a position slightly below MILITARY thrust. Between this throttle position and the maximum afterburning thrust position the main fuel control schedules engine speed as a function of CIT and modulates the variable area exhaust nozzle to maintain approximately constant rpm. Throttle movement in the afterburning range varies the afterburner fuel flow, nozzle position and thrust. At high Mach number and constant inlet conditions, the engine speed is essentially constant for all throttle positions down to and including IDLE. At a fixed throttle position, the engine speed will vary according to schedule when Mach number and CIT change.

The engine has a two stage turbine. Compressor discharge air cools the first stage and is then returned to the exhaust gas stream. Turbine discharge temperatures are monitored by indications of exhaust gas temperatures. A chemical ignition system is used to ignite the low vapor pressure fuel. A separate engine driven hydraulic system, using fuel as hydraulic fluid, operates the exhaust nozzle, chemical ignition system dump, compressor bypass and starting bleed systems. The main fuel pump, engine hydraulic pump and tachometer are driven by the main engine gearbox. The afterburner fuel pump is powered by an air turbine driven by compressor discharge air. The ac generator, aircraft hydraulic pumps and fuel circulating pump are located on a remote gearbox driven by the engine power takeoff pad through a reduction gearbox.

ENGINE THRUST RATINGS

The engine thrust ratings are defined by the power lever position at the main fuel control. The power lever is mechanically linked to the throttle, providing a relationship between throttle position and thrust ratings.

ENGINE AND A/B FUEL SYSTEM

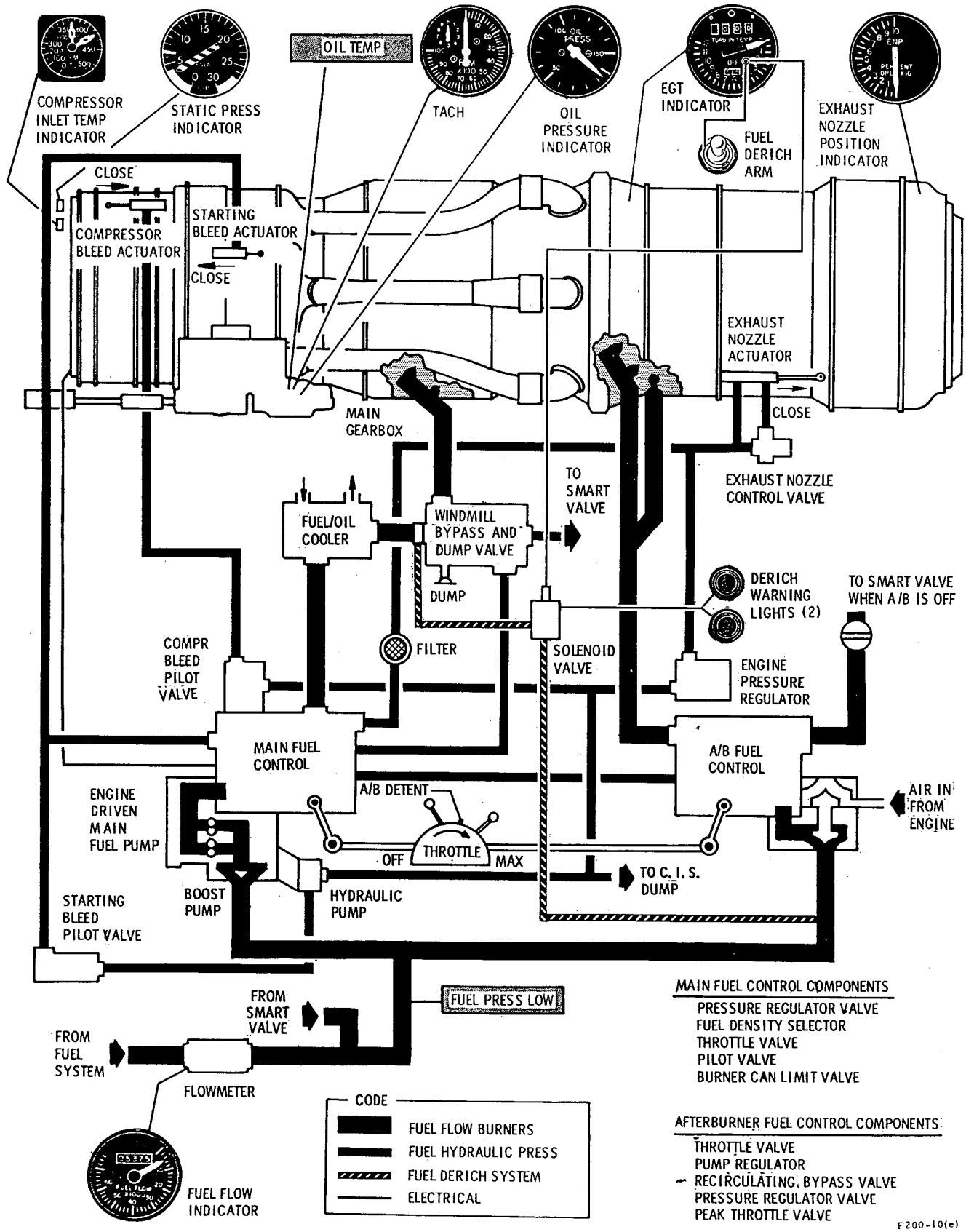


Figure 1-6

Maximum Rated Thrust

Maximum rated thrust is obtained in afterburning by placing the throttle against the quadrant forward stop.

Minimum Afterburning Thrust

MINIMUM afterburning thrust is obtained with the throttle just forward of the quadrant MILITARY thrust detent. Afterburner ignition is automatically actuated when the throttle is advanced past the detent and afterburner fuel flow is terminated when the throttle is retarded aft of the detent. Afterburning fuel flow and thrust are modulated by moving the throttle between the detent and the quadrant forward stop. Minimum afterburning is approximately 85% of maximum afterburning thrust at sea level and approximately 55% at high altitude. The basic engine operates at MILITARY rated thrust during all afterburning operation.

Military Rated Thrust

MILITARY rated thrust is the maximum non-afterburning thrust and is obtained by placing the throttle at the MILITARY thrust detent on the quadrant.

Idle

IDLE is a throttle position for minimum thrust operation. It is not an engine rating. Minimum thrust is always obtained when the throttle is at the IDLE stop on the quadrant.

Start

There is no distinct throttle position for starting. Starting is accomplished by moving the throttle from OFF to the IDLE position as the proper engine speed is reached. This directs fuel to the engine burners by actuation of the windmill bypass valve and actuates the chemical ignition system.

Off

The aft stop on the quadrant is the engine OFF throttle position. In this position, the windmill bypass valve cuts off fuel to the burners and bypasses it back to the aircraft system. This provides engine oil, fuel pump and fuel hydraulic pump cooling when an engine is windmilling at high Mach number.

ENGINE FUEL SYSTEM

Engine fuel system components include the engine driven fuel pump, main fuel control, windmill bypass valve and variable area fuel nozzles in the main burner section.

Main Fuel Pump

The engine driven main fuel pump is a two stage unit. The first stage consists of a single centrifugal pump acting as a boost stage. The second stage consists of two parallel gear type pumps with discharge check valves. The parallel pump and check valve arrangement permits one pump to operate in the event the other fails. The pump discharge pressure is determined by the regulating and metering function of the main fuel control. The maximum discharge pressure is approximately 900 psi. A relief valve is provided in the second stage discharge to prevent excessive fuel system pressure.

Main Fuel Control

The main fuel control meters main burner fuel flow, controls the bleed bypass and

start bleed valves and controls exhaust nozzle modulation. Thrust is regulated as a function of throttle position, compressor inlet air temperature, main burner pressure and engine speed. The bypass and start bleed valve positions are controlled as a function of engine speed biased by CIT. For steady state inlet conditions at high Mach number, the control provides essentially a constant engine speed at all throttle positions down to and including IDLE. On the ground and at lower Mach numbers, engine speed varies with throttle position from slightly below MILITARY down to IDLE. Afterburner operation is always at MILITARY rated engine speed and EGT. The fuel control is provided with a pilot operated trimmer for EGT regulation. There is no emergency fuel control system.

Windmill Bypass and Dump Valve

The windmill bypass and dump valve directs fuel to the engine burners for normal operation or bypasses fuel to the recirculation system for accessory, engine component and engine oil cooling during windmilling operation. The valve is actuated by signals from the main fuel control. The valve also opens to drain the fuel manifold when the engine is shut down.

Fuel Nozzles

The engine has eight can-annular type combustion chambers with forty-eight variable area dual orifice fuel nozzles in clusters of six nozzles per burner. The nozzles have a fixed area primary metering orifice and a variable area secondary metering orifice, discharging through a common opening. The secondary orifice opens as a function of primary orifice pressure drop.

ENGINE FUEL DERICHMENT SYSTEM

The derichment system provides protection against severe turbine over-temperature during high altitude operation. When EGT indicates 860°C or more with the system armed, the fuel:air ratio in the engine burner cans is reduced, or deriched, below normal values. This is accomplished by a solenoid operated valve and orifice which bypasses metered engine fuel from the fuel oil cooler to the afterburner fuel pump inlet. The solenoid valve is actuated by a signal from the EGT gage when 860°C is reached. Once actuated, it remains open until the system is turned off. Two warning lights are provided to indicate when the valve is open. Power for the derich circuits is provided from the essential dc bus.

Fuel Derichment Arming Switch

A two position fuel derichment arming switch is located on the left side of the instrument panel. In the ARM (up) position the derichment circuits are armed and the respective derichment solenoid valve will open automatically and remain open if the EGT reaches 860°C. In the OFF position the derichment solenoid valve is closed and the system can not provide derichment flow. Power is furnished from the essential d. c. bus.

Fuel Derichment Warning Lights

The fuel derichment warning lights, located on the left and upper center of the instrument panel, illuminate and remain on while the derichment solenoid valve is open. The lights will be extinguished when the arming switch is placed in the OFF position and will remain extinguished when the arming switch is reset to ARM if both EGTs are below 860°C.

WARNING

- In the event of derichment the arming switch must be placed in the OFF position prior to relighting the afterburner to prevent engine speed suppression and subsequent inlet unstart. If engine flameout is experienced with inlet unstart the arming switch should also be placed to OFF prior to relighting the engine.

- Derichment at sea level will cause a thrust loss of approximately 5% if in maximum afterburning or 7% if at Military. Approximately 45% loss in thrust and 600 rpm speed suppression will occur during cruise with maximum afterburning.

AFTERBURNER FUEL SYSTEM

Afterburner fuel system components include the centrifugal afterburner fuel pump, afterburner fuel control and spray bars.

Afterburner Fuel Pump

The afterburner fuel pump is a high speed, single stage centrifugal pump. The pump is driven by an air turbine which is operated by engine compressor discharge air. The compressor discharge air supply is regulated by a butterfly valve in response to the demand of the afterburner fuel control. The turbine is protected from overspeed by an aero-dynamic speed limiting air discharge venturi.

Afterburner Fuel Control

The afterburner fuel control is a hydromechanical fuel control which schedules metered fuel flow as a function of throttle position, main burner pressure and compressor inlet temperature. Fuel flow is metered on a predetermined schedule to provide fuel into both zones of the afterburner spray bars simultaneously. The control incorporates a reset mechanism which increases the afterburner fuel flow when the bypass valves open and decreases the fuel flow when the valves close.

ENGINE FUEL HYDRAULIC SYSTEM

Each engine is provided with a fuel hydraulic system for actuation of the afterburner exhaust nozzle and the start and bypass bleed valves. Engine hydraulic system pressure is also required to dump the unused chemical ignition fluid. Pressure is supplied by a high temperature, engine driven, variable delivery, piston type pump. The pump maintains system pressures up to 2500 psi with a maximum flow of 50 gpm for transient requirements. Engine fuel is supplied to the pump from the main fuel pump boost stage. Some high pressure fuel is diverted from the hydraulic system to cool the non-afterburning recirculation line and the windmill bypass valve discharge line. This fuel is returned to the aircraft system. Low pressure fuel from the hydraulic pump case is returned to the main fuel pump boost stage. Hydraulic system loop cooling is provided by the compensating fuel supplied from the main fuel pump.

Exhaust Nozzle Actuation

The exhaust nozzle control and actuation system is composed of four actuators to move the exhaust nozzle, and an exhaust nozzle control modulating the hydraulic pressure to the actuators in response to engine speed signals from the main fuel control. The exhaust nozzle control is mounted on the aft portion of the engine. A pressure regulator is contained in a separate unit located near the exhaust nozzle control.

START BLEED AND BYPASS VALVE ACTUATION

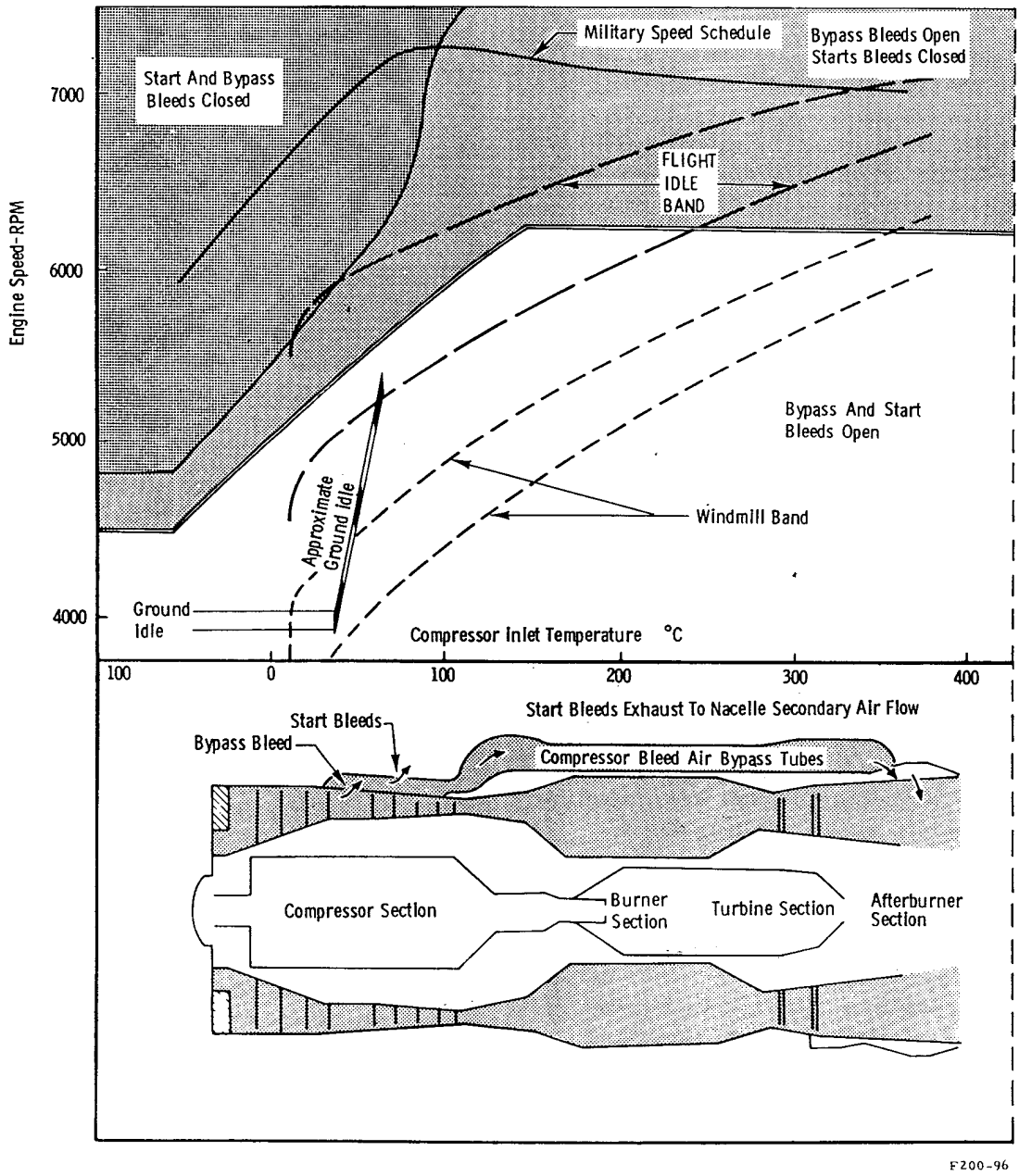


Figure 1-7

Start and Bypass Bleed Valve Actuation

The bypass bleed control and actuation system consists of four two-position actuators to move the bleed valves, and a pilot valve to establish the pressure to the actuators. The pilot valve controls the bleed valve position in response to a mechanical signal from the main fuel control. Bleed valve position is scheduled within the main fuel control as a function of engine speed and compressor inlet temperature. The starting bleed control and actuation system is similar to the bypass bleed system except that three actuators are used and the pilot valve controls starting bleed valve position in response to the main fuel pump boost stage pressure rise.

EXHAUST NOZZLE AND EJECTOR SYSTEM

The variable area, iris type, exhaust nozzle is comprised of segments operated by a cam and roller mechanism and four hydraulic actuators. The actuators are operated by fuel hydraulic system pressure. The exhaust nozzle is enclosed by a fixed contour, convergent-divergent ejector nozzle to which free floating trailing edge flaps are attached. In flight, the inlet cowl bleed supplies secondary airflow between the engine and nacelle for cooling. During ground operation, suck in doors in the aft nacelle area provide cooling air. Free floating doors around the nacelle, just forward of the ejector, supply tertiary air to the ejector nozzle at subsonic Mach numbers. The tertiary doors and trailing edge flaps open and close with varying internal nozzle pressure, which is a function of Mach number and engine thrust.

Exhaust Nozzle Position Indicator

Each engine is provided with a nozzle position indicator located on the right side of the instrument panel. The indicators are marked from 0 to 10 and indicate the approximate percentage of open position. Additional dot markings above and below the 0 and 10 position marks are for calibration purposes. The indicators are remotely operated by electrical transducers located near the exhaust nozzles. Each transducer is cooled by fuel and is operated by the afterburner nozzle feedback link. Power for the indicators is supplied by the No. 1 inverter.

OIL SUPPLY SYSTEM

The engine and reduction gear box are lubricated by an engine contained, "hot tank", closed system. The oil is cooled by circulation through an engine fuel-oil cooler. The oil tank is mounted on the lower right side of the engine compressor case and has a usable capacity of 4.5 gals. Total tank capacity is 6.7 gals. The oil is gravity fed to the main oil pump which forces the oil through a filter and the fuel-oil cooler. The filter is equipped with a bypass in case of clogging. From the fuel-oil cooler the oil is distributed to the engine bearings and gears. Oil screens are installed at the lubricating jets for additional protection. Scavenge pumps return the oil to the tank where it is deaerated. The main oil pump normally maintains an oil pressure of 40 to 55 psi. A pressure regulating valve keeps flow and pressure relatively constant at all flight conditions. Because of the high viscosity of the oil, it is diluted with trichloroethlene at lower temperatures and special cold weather shut down procedures may be required.

Main Fuel-Oil Cooler

This unit provides oil cooling by using engine fuel to absorb the heat. The oil temperature is controlled by fuel flow through the cooler. A bypass valve is incorporated to bypass fuel around the cooler when the fuel flow is greater than the cooler flow capacity of approximately 12,000 pounds per hour.

CHEMICAL IGNITION SYSTEM

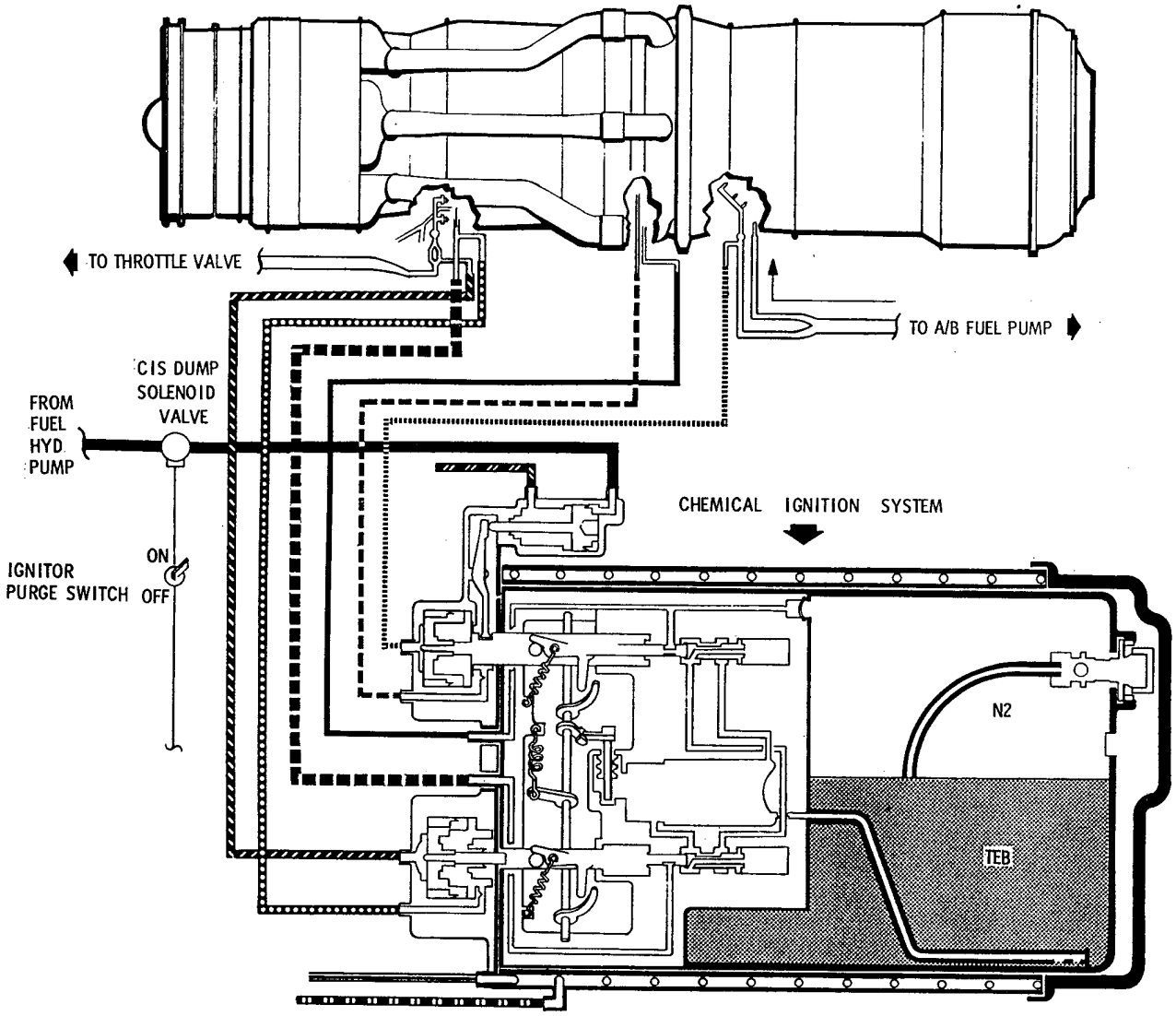


Figure 1-8

Oil Quantity Low Lights

An indicator light for each engines oil system is located on the lower instrument annunciator panel. The lights are labeled L and R OIL QTY LOW and illuminate when the respective engine oil quantity is reduced to 2.25 gals. Power is furnished by the essential dc bus.

Engine Oil Temperature Light

L and R OIL TEMP lights are installed on the annunciator panel. These lights will illuminate when respective engine oil inlet temperature is less than $+15.6^{\circ} \pm 3^{\circ}C$ or greater than $282^{\circ}C \pm 11^{\circ}C$.

Remote Gear Box Oil System

The remote gear box contains an independent, wet sump lubricating system with its own oil supply and pressure pump. There is no scavenge pump. It is vented to the engine breather system through the remote gear box drive shaft. The oil is cooled by circulation through the remote gear box fuel-oil heat exchanger.

CHEMICAL IGNITION SYSTEM

Triethylborane (TEB) is used for ignition of main burner and afterburner fuel. Special handling procedures are required because TEB above $0^{\circ}F$ will burn spontaneously upon exposure to air above $-4^{\circ}F$. The TEB is contained in a 600 cc (1-1/4 pint) storage tank pressurized with nitrogen. The nitrogen provides inerting and operating pressure to supply a metered quantity of TEB to either the main burner or afterburner section. Operation is in response to a fuel pressure signal from the appropriate system. Actuation is automatic with throttle movement. A mechanical counter for each engine, located aft of the throttles, indicate TEB shots remaining. A minimum of 16 injections can be made with one full tank of TEB. The TEB tank is engine mounted and is cooled by main burner fuel to maintain the TEB temperature within safe limits. If the TEB vapor pressure exceeds a safe level, a rupture disc is provided to discharge the vaporized TEB and tank nitrogen through the afterburner section. No pilot indication of TEB tank discharge is provided. The engine is also equipped with catalytic igniters installed on the afterburner flameholders to provide improved afterburner ignition system reliability and relight capability. Turbine exhaust temperature must be above approximately $730^{\circ}C$ to obtain a satisfactory afterburner "light" by the catalytic igniters.

Igniter Purge Switch

A lift-lock toggle switch labeled IGNITER PURGE is installed on the upper right side of the instrument panel. When the switch is pulled out and held in the up position a solenoid operated valve supplies fuel hydraulic system pressure to the chemical ignition system dump valve. This allows the remaining TEB to be dumped into the afterburner section; while the engine is running. Approximately 40 seconds is required. Electrical power is furnished by the essential dc bus.

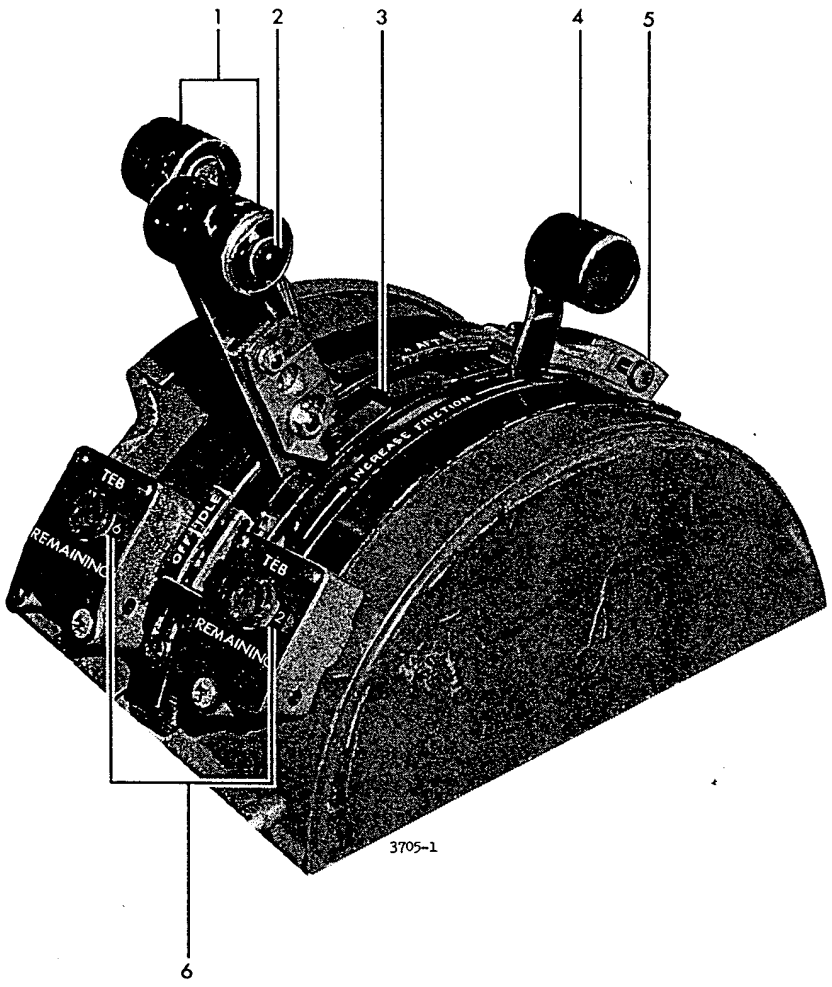
NOTE

Both electrical power and engine fuel hydraulic pressure are necessary to purge the TEB system. If the engine is not rotating the system will not normally dump.

CAUTION

Do not actuate the Igniter Purge switch unless the engine is rotating in the 5000-6000 rpm range to prevent damage to the afterburner flame holders.

THROTTLE QUADRANT



1 THROTTLES
2 TRANSMIT BUTTON
3 MILITARY DETENT
4 THROTTLE FRICTION LEVER
5 MAX AFTERBURNER STOP
6 TEB SHOT COUNTERS

REV-11-18-64
FMA12-13-(a)

Figure 1-9

STARTER SYSTEM

A starter cart is provided for ground starts. This may be either a self-contained gas engine cart or multiple air turbine cart. The output drive gear of either cart connects to a starter gear on the main gear box at the bottom of the engine. There are no aircraft controls for this system. It is turned on and off by the ground crew in response to signals from the pilot. Air starts are made by windmilling the engine.

THROTTLES

Two throttle levers, one for each engine, are located in a quadrant on the left forward console. The right throttle is mechanically linked to the right engine main fuel control and the left throttle to the left engine afterburner fuel control with parallelogram type linkages designed to compensate for heat expansion. The afterburner and main fuel controls are interconnected by a closed loop cable. The throttle quadrant is labeled OFF, IDLE and AFTERBURNER. When the throttles are moved forward from OFF to IDLE, they drop over a hidden ledge to the IDLE position. This ledge prevents inadvertent engine cutoff when the throttles are retarded to IDLE. When retarding the throttles from IDLE to OFF they must be lifted in order to clear the IDLE stop ledge. Forward throttle movement from IDLE to a MILITARY stop controls the non-afterburning thrust range of the engine. The throttles must be slightly raised to clear the stop before additional forward movement of the throttle can actuate the afterburner ignition. The AFTERBURNER range extends from the Military stop to the quadrant forward stop. The right throttle knob incorporates a radio transmission pushbutton switch. Throttle quadrants are marked to indicate 82° power lever angle (PLA) for assistance in determining the cruise power position.

Throttle Friction Lever

The throttles are prevented from creeping by a friction lever located on the inboard side of the throttle quadrant. When the lever is full aft, the throttles are free to move. Moving the lever forward as the INCREASE FRICTION label indicates, progressively increases the amount of friction to hold the throttles in the desired position.

TEB Remaining Counters

A mechanical TEB remaining counter for each engine is located aft of each throttle. The counters are spring wound and set to 12 prior to engine start. Each time a throttle is moved forward from OFF to IDLE or MILITARY to A/B the counter will reduce one number.

Exhaust Gas Temperature Trim Switches

Individual exhaust gas temperature trim switches for each engine are located on the lower left side of the instrument panel. The switches are spring loaded, momentary contact, three position switches with a center OFF position. When held in the INCREASE (up) position, a remote trim electric motor on the engine fuel control is actuated to slightly increase main burner fuel flow and turbine inlet temperature. The trim motors have a fuel flow or EGT travel range of about 150°C and a rate of change of 8°C per second. When held in the DECREASE (down) position, the trim motor reduces the fuel flow and decreases turbine inlet temperature. An increase or decrease in turbine inlet temperature will be reflected on the respective exhaust gas temperature gage. These switches are the only provision for main engine control when the throttles are in the afterburning range. They have no effect on rpm when the nozzle is modulating to provide the scheduled engine speed. Power for the trim motors is furnished by the respective ac generator bus.

ENGINE INSTRUMENTS

Exhaust Gas Temperature Gages

Two exhaust gas temperature gages, one for each engine, are mounted on the right side of the instrument panel. They are calibrated in degrees centigrade from 0°C to 1200°C and indicate the temperature sensed by turbine discharge thermocouples. The four digit windows at the top of the gages indicate the exhaust gas temperature to the nearest degree. An OFF window at the bottom of each dial when visible indicates instrument power failure. A small red light on the dial will light when EGT reaches 860°C. This will activate the respective derichment system if armed. The indicating system receives power from the No. 1 inverter.

Fuel Flow Indicators

A fuel flow indicator for each engine is mounted on the instrument panel and displays total fuel flow (engine and afterburner) in pounds per hour. The dial is calibrated in 2000 pound per hour increments to 76,000 pph. The five digit center window indicates the fuel flow to the nearest 100 pph. The indicator is not compensated for return flow and indicates total fuel flow to engine, afterburner and heat sink system. A positive indication is normal during windmill operation and the indicator will read high when the mixer and temperature control valve is diverting cooling loop fuel back to tank 4. During descent after high speed cruise both high and low fuel flows and flow oscillations may be indicated. Power for the indicators is supplied by the No. 1 inverter.

Tachometers

A tachometer for each engine is mounted on the right side of the instrument panel. The tachometers indicate engine speed in revolutions per minute. The main pointer is calibrated up to 10,000 rpm and the subpointer makes one complete revolution for each 1000 rpm. The tachometers are self-energized and operate independently of the aircraft electrical system.

Engine Oil Pressure Gages

An oil pressure gage is provided for each engine on the right side of the instrument panel. The gages indicate output pressure of the respective engine oil pump in pounds per square inch. The gages are calibrated from 0 to 100 psi in increments of 5 psi. Power for the gages is furnished by the No. 1 inverter bus through the 26-volt autotransformer.

Compressor Inlet Temperature Gage

A dual indicating compressor inlet temperature gage is mounted on the upper right side of the instrument panel. It is calibrated in 50° increments from 0°C to 300°C and 10° increments from 300°C to 500°C. The needles indicate the air temperature forward of the first compressor stage of each nacelle. The system uses platinum resistance sensors and power is furnished by the No. 1 inverter.

Compressor Inlet Air Static Pressure Gage

A dual indicating compressor inlet air static pressure gage located on the upper center of the instrument panel, measures absolute pressure at the engine compressor inlet. The gage is calibrated in one psi increments and has marked red ranges from 0 to 4 psi and 27 to 30 psi and a green radial mark at 7 psi. A white striped third pointer on the CIP gage indicates pressure to be expected when the inlets are operating normally if over Mach 1.8 and 250 KEAS. The L and R labeled pointers indicate actual inlet static pressures. Power is furnished from the No. 1 inverter.

AIR INLET SYSTEM

The air inlets for each nacelle are canted inboard and down to align with the local airflow pattern. The inlet system consists of the cowl structure, a moving spike to help provide optimum internal airflow characteristics, a spike porous centerbody bleed and an internal cowl shock trap bleed for internal shock wave position and boundary layer flow control, forward and aft bypass doors for control of airflow in the inlet and to the engine, cowl exhaust louvers, system controls, sensors, actuators and instrumentation. Suck-in doors are also provided in the aft nacelle area for ground cooling. Nacelle cooling air is provided in flight by air from the cowl shock trap bleed and aft bypass. Normally, the spike and forward bypass are operated automatically by the air inlet control system. Inlet airflow is controlled so that the proper amount of air is supplied to the engine and, at supersonic airspeeds, the positions of shock waves ahead of the inlet and in the inlet throat are controlled so as to provide maximum practical ram pressure recovery at the engine face. Controls are provided in the cockpit for incremental control of the aft bypass for those conditions where additional bypass area is required or where a reduction in forward bypass flow is desired. Manual controls are provided to override the automatic spike and forward bypass control systems.

INLET SPIKE

The spike is locked in the forward position for ground operation and flight below 30,000 feet. It is unlocked above this altitude and is programmed during automatic operation to move 1/4 inch off the forward stop at Mach 1.4. Above Mach 1.6, the spike retracts so as to increase the nacelle inlet area and decrease the area of the throat or narrowest portion of the duct. Spike position is scheduled primarily as a function of Mach number as sensed by the Rosemount boom pitot static ports with biasing for angle of attack and yaw angle. The spike moves aft approximately 26 inches during transition between Mach 1.6 and 3.2. The inlet control also includes a shock expulsion sensor (SES) and restart feature which can operate automatically when speeds for inlet scheduling are reached. It is effective above approximately Mach 2.0. If an inlet becomes unstable and expels the internal shock, the shock expulsion sensor for that inlet overrides the automatic spike and forward bypass schedule. It causes the forward bypass to open fully and the spike to move forward as much as 15 inches. Spike retraction is started automatically 3.75 seconds after the expulsion is sensed and, when schedule position is reached, the forward bypass is returned to automatic operation. The SES reference pressure is CIP, and the system is triggered when a momentary decrease of CIP is 23% or more. This is a characteristic CIP indication of inlet unstart occurrence. However, it may also operate as a result of pressure fluctuations if CIP decreases rapidly below the previous normal condition during compressor stalls. The SES feature does not override a manually operated spike or forward bypass control. Manual operation of a restart switch overrides the SES operation for that inlet. Spike and forward bypass door position changes may be observed during SES operation on the spike and forward bypass position indicators. Local pitch attitude and yaw angle are sensed by a pressure probe mounted on the Rosemount pitot boom. The spike porous centerbody bleeds boundary layer air from the inlet throat to prevent flow separation. This air is ducted overboard through the supporting struts and nacelle louvers. The spikes can be fully controlled by use of cockpit controls when hydraulic pressure is available. Emergency spike forward

switches provide pneumatic pressure to move and lock the spikes forward in the event of hydraulic system failure.

INLET FORWARD BYPASS

The forward bypass provides an exhaust for inlet air which is not required by the engine, and controls the inlet diffuser pressure so as to properly position the inlet shock. It consists of a rotating basket which opens duct exhaust ports located a short distance aft of the inlet throat. When the landing gear is down, the forward bypass doors are held open by an electrical override signal from a landing gear door switch. The switch is positioned to allow manual or automatic control of the bypass when the landing gear retracts. In automatic operation, the forward bypass remains closed until a low supersonic speed is reached, then it modulates in accordance with air inlet control system Mach and pressure schedules. The inlet usually "starts" at Mach 1.4, that is, the inlet shock is positioned near the cowl shock trap bleed in the inlet throat area. As speed is increased, the forward bypass schedules as required to maintain the inlet shock at the throat position.

The forward bypass position is controlled by the ratio of inlet duct static pressure to a reference total pressure. The inlet duct static pressure is sensed by taps located aft of the shock trap bleed.

The reference total pressure is sensed by two external probes one located on the lower inboard side of the nacelle and the other at the top of the nacelle. The forward bypass control also senses an unstart as a result of the sudden decrease in pressure at the engine face and controls the inlet through a timed sequence. The minimum Mach number at which the automatic restart actuates varies with the intensity of the unstart but is generally in the vicinity of Mach 2.0. An overriding switch holds the forward bypass closed at speeds lower than Mach 1.4.

INLET AFT BYPASS

The aft bypass consists of a ring of adjustable peripheral openings allowing a maximum mass flow of approximately 3/4 of that available from the forward bypass. The ring is located just forward of the engine face. These openings allow excess inlet air to be bypassed around the engine. The bypassed air joins cowl shock trap bleed air and passes between the outside of the engine and afterburner and the inside of the nacelle. This flow augments the exhaust gas in the ejector area. Each aft bypass ring is positioned by a hydraulic actuator which is powered by the respective L or R hydraulic system and is controlled by the cockpit switch. The bypass is held closed during takeoff and landing by an electrical signal from the nose gear downlock. It is also closed during subsonic operation. Position in flight is set manually in accordance with determined Mach number and engine operating requirements.

INLET AIRFLOWS

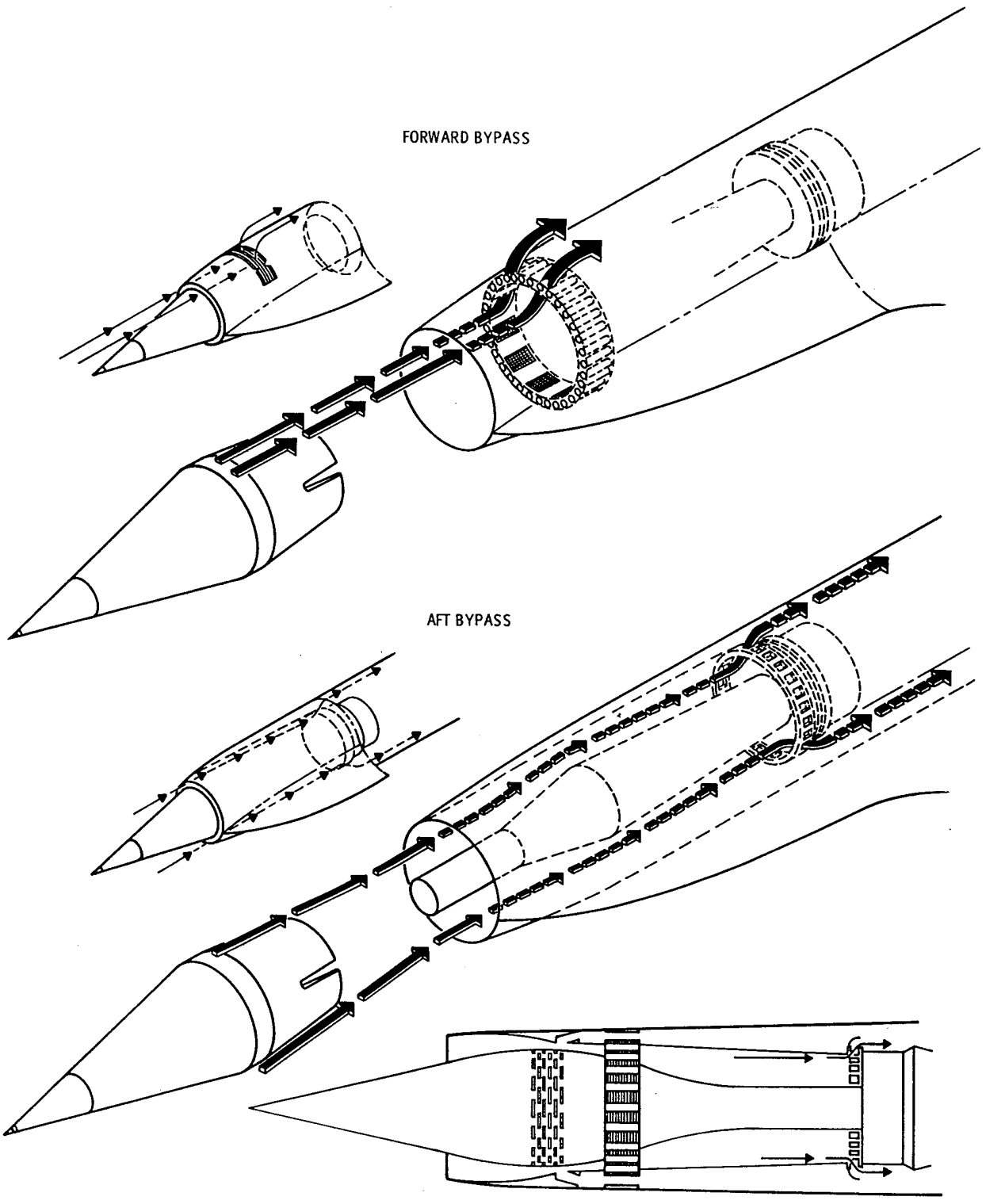
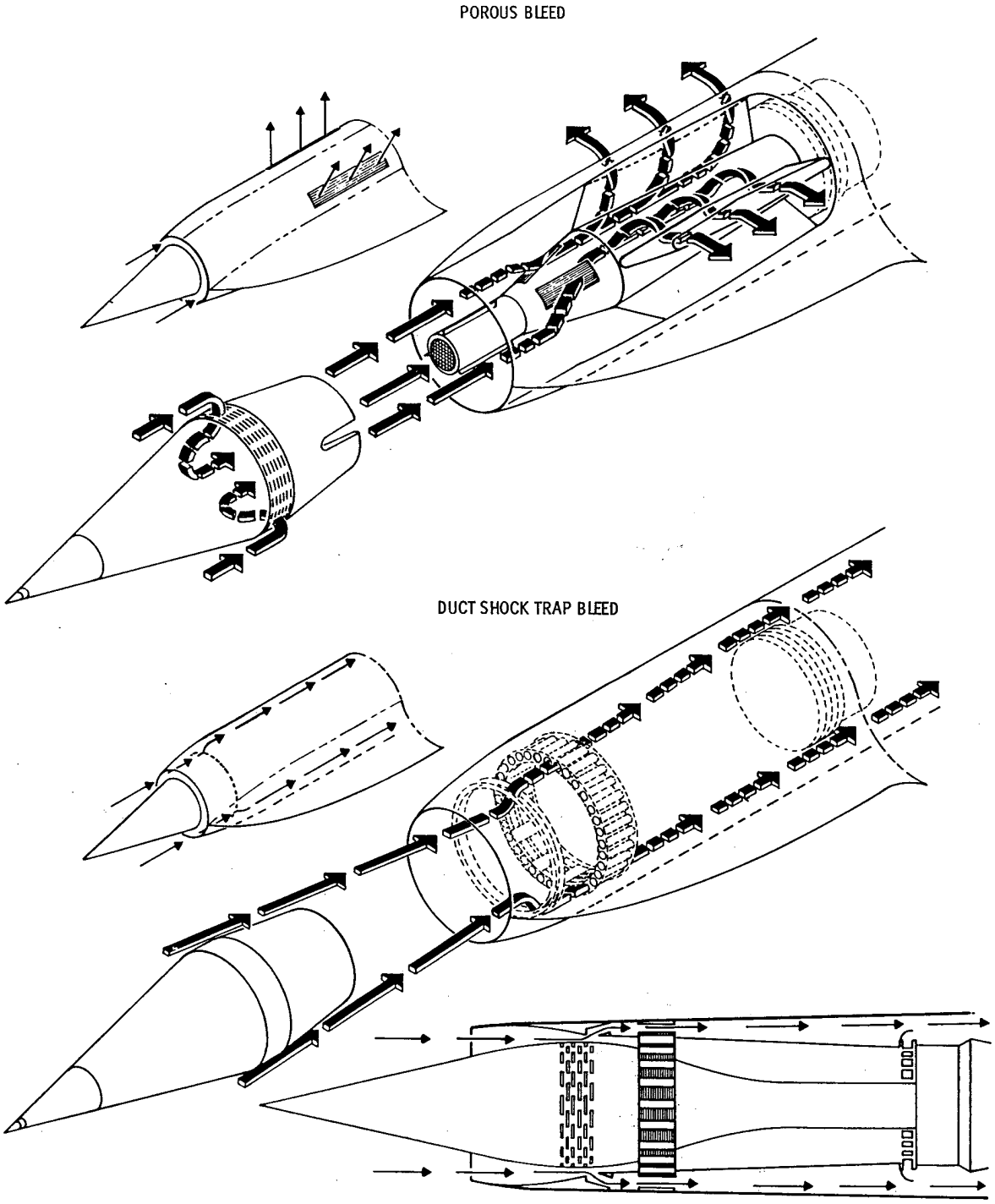


Figure 1-10 (Sheet 1 of 2)

INLET AIRFLOWS



NOTE

DUCT SHOCK TRAP BLEED AIR FLOWING THROUGH THESE TUBES REACHES NACELLE SECONDARY AREA AND EXHAUSTS THROUGH EJECTOR.

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Figure 1-10 (Sheet 2 of 2)

AIR INLET CONTROL SYSTEM

The air inlet control system incorporates a computer which utilizes electrically transmitted pneumatic pressure signals to automatically schedule and reposition the spikes and forward bypass. The computer also serves as a calibrated path for the manual spike and manual forward bypass control. Major components for each inlet control are the computer, pressure transducer, angle transducer and two pressure ratio transducers. The spike and forward bypass controls consist of four rheostat type knobs and two inlet restart switches and an emergency spike switch. Aft bypass control is by means of two rotary type switches located above the throttle. Three annunciator panel lights are pertinent to the inlet control system.

Nine different pressures are sensed for inlet control. The Rosemount airspeed boom provides pitot total and static pressures to the pitot pressure transducer. The pitch and yaw attitude probe on the left side of the boom provides angle of attack and yaw angle pressures for conversion to electrical signals by the attitude transducer. At each nacelle local pitot pressure and two inlet duct static pressures are sensed to enable two sensors within the pressure ratio transducer to convert pressure ratios to electrical signals which (1) direct forward bypass control, and (2) cause an automatic restart following shock expulsion. Some control functions are also accomplished within the pressure transducer. Most of the electrical outputs of the pitot pressure transducer, attitude transducer, and both pressure ratio transducers are transmitted to the computer. The computer also receives a signal from the main landing gear doors to assure that the forward bypass will be open whenever the main gear is down.

Spike Controls

The L and R spike controls are located on the lower left side of the instrument panel. The controls are labeled AUTO, FWD, and have labeled marks for 1.4, 1.8, 2.2, 2.6, 3.0 and 3.2 Mach numbers. Intermediate marks for 0.1 Mach increments allow the knobs to be positioned manually at any setting from 1.4 to 3.2 Mach number. In the detented AUTO position, spike position is scheduled automatically by the inlet control system. In the detented FWD position, the spike will move to the full forward position. The Mach numbered positions are used in manual operation. Use of settings corresponding to aircraft flight Mach number moves the spike aft to the correct position for proper inlet performance. The spike control also biases the forward bypass as a function of control knob position when the bypass is being manually controlled. The forward bypass position indicator and bypass control knob will not be in agreement by the amount of bias. Control power for the left spike is from the No. 2 inverter and for the right spike the No. 3 inverter.

Forward Bypass Controls

The L & R BYPASS controls are located just inboard of the spike controls. When a control is turned full counterclockwise to the detented AUTO position, operation of the respective forward bypass is automatically controlled by the inlet computer. As the control is turned clockwise the first detented position will position the forward bypass to the full open. As the control is turned further clockwise the forward bypass will incrementally move towards the closed position and will be fully closed in the full clockwise position. Markings from 0 to 100 in increments of 10 percent allow the control to be positioned at any percentage of full open. Power for the circuits is from the essential dc bus and No. 2 and No. 3 inverters.

AIR INLET CONTROLS AND INDICATORS

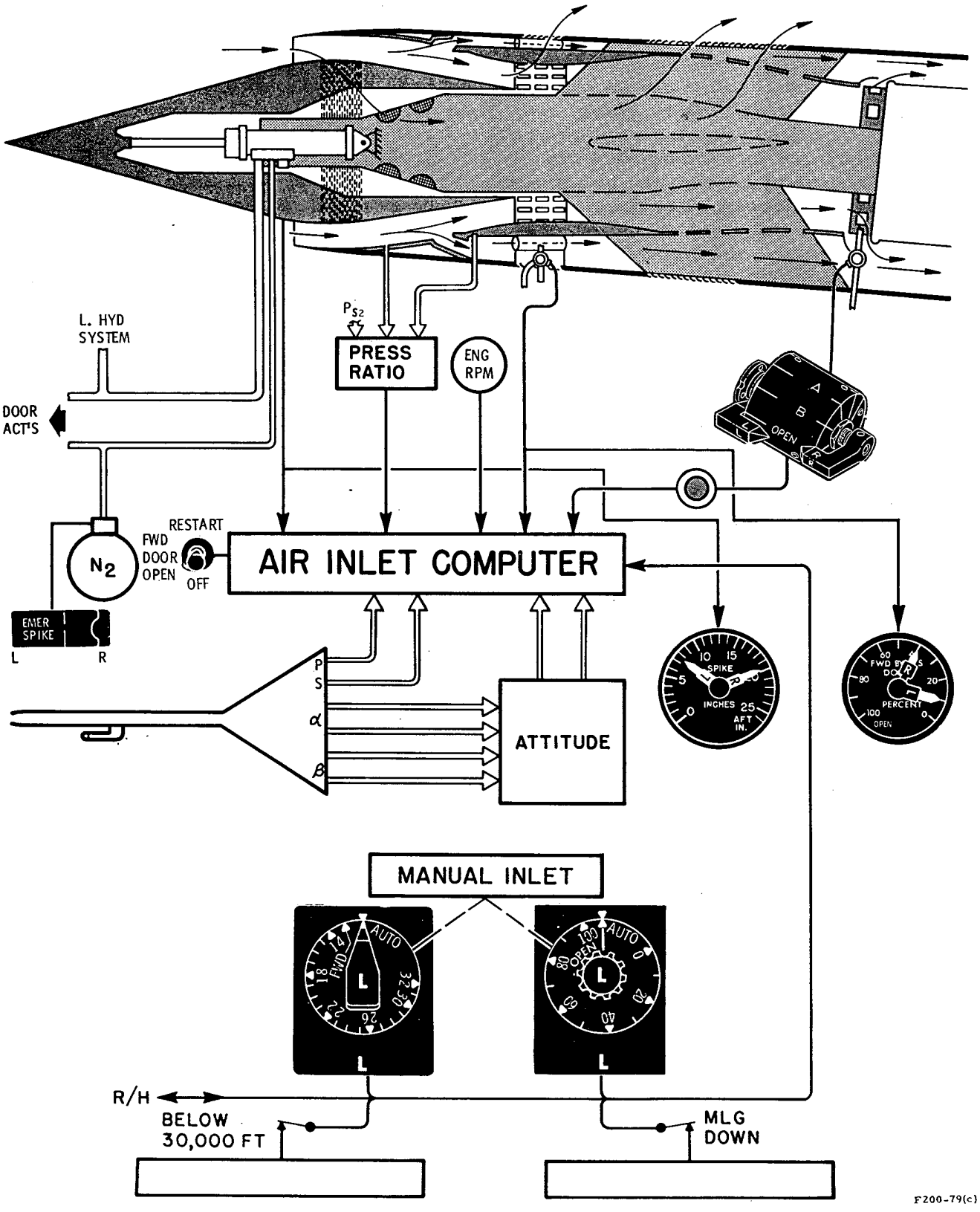


Figure 1-11

CAUTION

Manual operation of the forward bypass is permissible with the spike operating on its automatic schedule; however, when the spike is operated manually, the forward bypass must be operated manually or the bypass will open fully and will not schedule.

Inlet Restart Switches

Two 3-position toggle switches are located on the left side of the instrument panel. The L & R switches are labeled RESTART (up), FWD DOOR OPEN (center) and OFF (down). In the RESTART position the spike and bypass control settings are overridden, the forward bypass is opened and the spike is moved forward. In the center FWD DOOR OPEN position the forward door is moved to/or held open but the spike position responds to its control knob. In the OFF position both the spike and forward bypass are controlled by their respective controls. Power for the restart circuit is supplied by the essential dc bus.

Emergency Spike Switch

A single 3-position guarded switch, labeled EMER SPIKE, is provided below the instrument panel. The switch is guarded in the center OFF position. After the guard is opened the switch may be positioned in either L or R positions as necessary. In the event of L or R hydraulic failure, the one shot emergency pneumatic bottle in the respective nacelle is activated to drive and lock the spike in the full forward position. Power for the emergency spike circuit is from the essential dc bus.

Inlet Aft Bypass Switches and Indicator Lights

The inlet aft bypass switches and indicator lights are located above the throttle quadrant. They are four-position rotary type switches equipped with concentric lever handles. The switch positions from top to bottom are labeled CLOSED, A (15% open), B (50% open), OPEN (100%). Left and right amber lights, located near the switch levers illuminate to indicate when an aft bypass position and the switch setting do not correspond. A light should illuminate each time its switch is moved, then extinguish as the bypass reaches the required position. Approximately 5 seconds is required for the aft bypass to move from full closed to full open. The aft bypass actuator control circuits are powered by the essential dc bus.

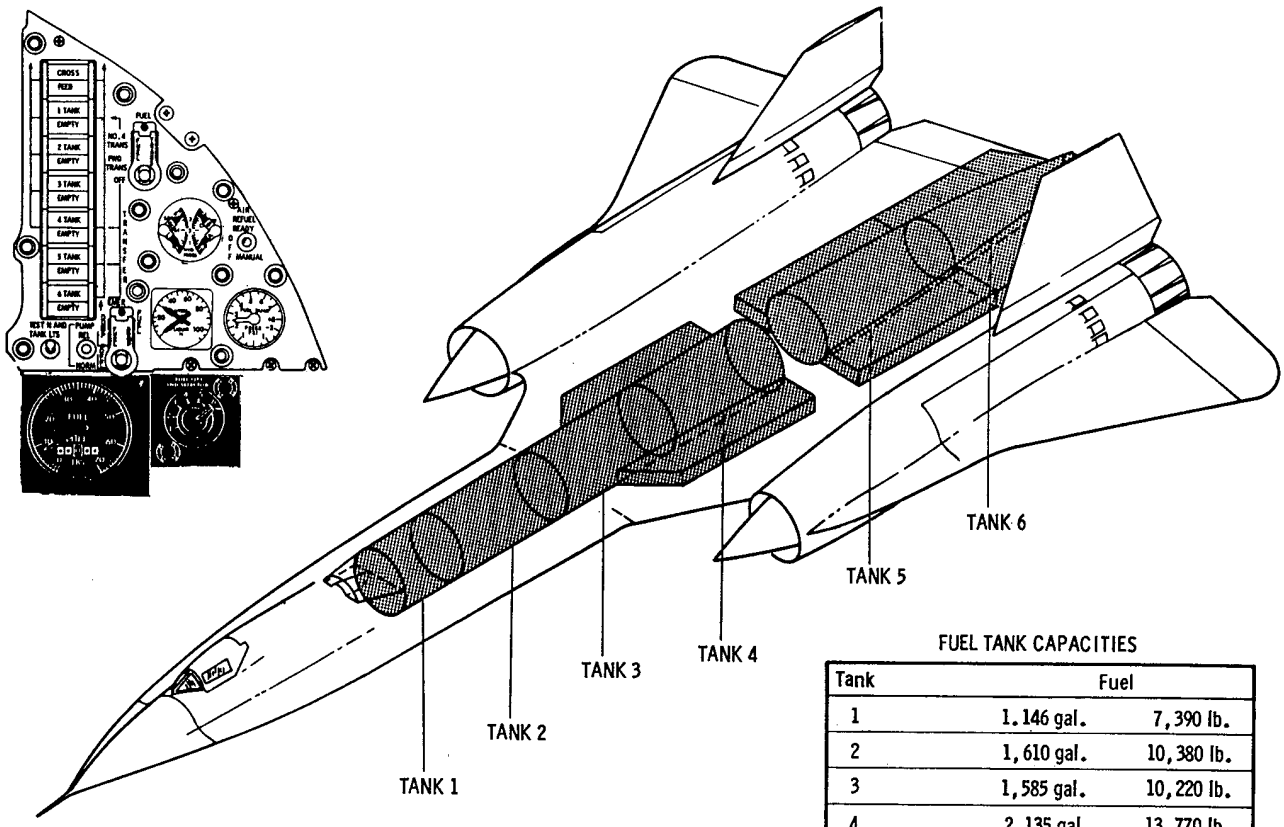
Spike Position Indicator

A dual spike position indicator is located on the lower right side of the instrument panel. The L & R labeled pointers indicate the position of the respective spike in inches aft of the forward position. It is calibrated in inches from 0 to 26 with 5, 10, 15, 20, and 25 inch labeling. Power is furnished from the No. 2 inverter for the left spike and the No. 3 inverter for the right spike.

Forward Bypass Position Indicator

A dual forward bypass position indicator is located on the lower right side of the instrument panel. The L & R labeled pointers indicate the opening of the respective forward bypass in 10% increments. Labeled positions are 20, 40, 60, 80 and 100 OPEN. Power is furnished from the No. 2 inverter for the left bypass and the No. 3 inverter for the right bypass.

FUEL QUANTITY DATA



FUEL TANK CAPACITIES

Tank	Fuel	
1	1,146 gal.	7,390 lb.
2	1,610 gal.	10,380 lb.
3	1,585 gal.	10,220 lb.
4	2,135 gal.	13,770 lb.
5	2,136 gal.	13,780 lb.
6	1,978 gal.	12,760 lb.
TOTAL	10,590 gal.	68,300 lb.

*At average fuel density of 6.45 lb./gal.

F200-61(c)

Figure 1-12

Manual Inlet Indicator Light

The annunciator panel MANUAL INLET light, when illuminated, indicates that one or more of the four rotary spike and forward bypass controls is not in the AUTO position or that an inlet restart switch is not in the OFF position. Power for the light is furnished by the essential dc bus.

FUEL SUPPLY SYSTEM

There are six individual fuel tanks, identified from forward to aft as tanks 1, 2, 3, 4, 5, and 6. Interconnecting plumbing and electrically driven boost pumps are utilized for fuel feed, transfer, and dumping. Other components of the system include pump controls, nitrogen inerting, scavenging, pressurization and venting, a single-point refueling receptacle, and a fuel quantity indicating system. In addition to furnishing fuel to the engines, automatic fuel manage-

ment provides center of gravity and trim drag control. The fuel is also used to cool cockpit air, engine oil, accessory drive system oil, and hydraulic fluid by means of the fuel heat sink system.

FUEL TANKS

The integral, internally sealed, fuel tanks are contained in the fuselage and wing root. The tanks are interconnected by right and left fuel manifolds and a single vent line. Submerged boost pumps supply fuel through the manifolds and transfer fuel for c.g. control. Forward transfer is accomplished by manual control of the right manifold. Aft transfer is accomplished automatically through the left manifold. A fuel dump valve is installed in each fuel manifold. Normal sequence of tank usage is controlled by float switches to automatically maintain an optimum c.g. for cruise. The left engine is normally sequenced from tanks 1, 2, 3, and 4, the right engine is sequenced from tanks 1, 6, 5, and 4. Normal automatic tank sequencing is as follows:

L Engine	R Engine
Tank 1 and 2	Tanks 1 and 6
Tank 2	Tank 6
Tank 3	Tank 6
Tank 3	Tank 5
Tank 4	Tank 5
Tank 4	Tank 4

The fuel manifolds can be connected by depressing the crossfeed switch. This operates a motor operated valve between the fuel manifolds and is mainly used during single engine operation.

REFUELING AND DEFUELING

A single point refueling receptacle installed on top of the fuselage aft of the air conditioning bay is used for both ground and in-flight refueling. Ground refueling is accomplished by use of an in-flight refueling probe specially modified to utilize a hand operated locking device so that refueling may be done without hydraulic power. Fuel from the receptacle flows through the fueling manifold to each tank. The use of a different size orifice for each tank allows all tanks to be filled simultaneously in approximately 15 minutes with a nozzle pressure of 50 psi. Dual shutoff valves in each tank terminate refueling flow when the tank is full. A defueling fitting is installed on the right fuel feed manifold in the lower right side of tank 3. Tanks 2 and 3, which feed the left manifold, are defueled by opening the crossfeed valve.

CAUTION

Any fuel in tanks 5 and 6 must be balanced with a like amount of fuel in the other tanks during ground fueling or defueling to prevent the aircraft from rocking down on the tail.

FUEL TANK CAPACITIES

See figure 1-12.

FUEL BOOST PUMPS

Sixteen single stage centrifugal ac powered boost pumps are used to supply the fuel manifolds. Tanks 1 and 4, which normally feed both engines, are equipped with four pumps and tanks 2, 3, 5 and 6 have two pumps each. Either pump of a pair is capable of supplying fuel to its manifold at a rate sufficient for normal engine operation in the event of a failure of the other pump. The pumps in each tank may be operated out of the normal sequence by use of the individual tank boost pump control switches located on the right side of the instrument panel. These switches supplement auto-

FUEL SYSTEM
Feed-Transfer-Dump

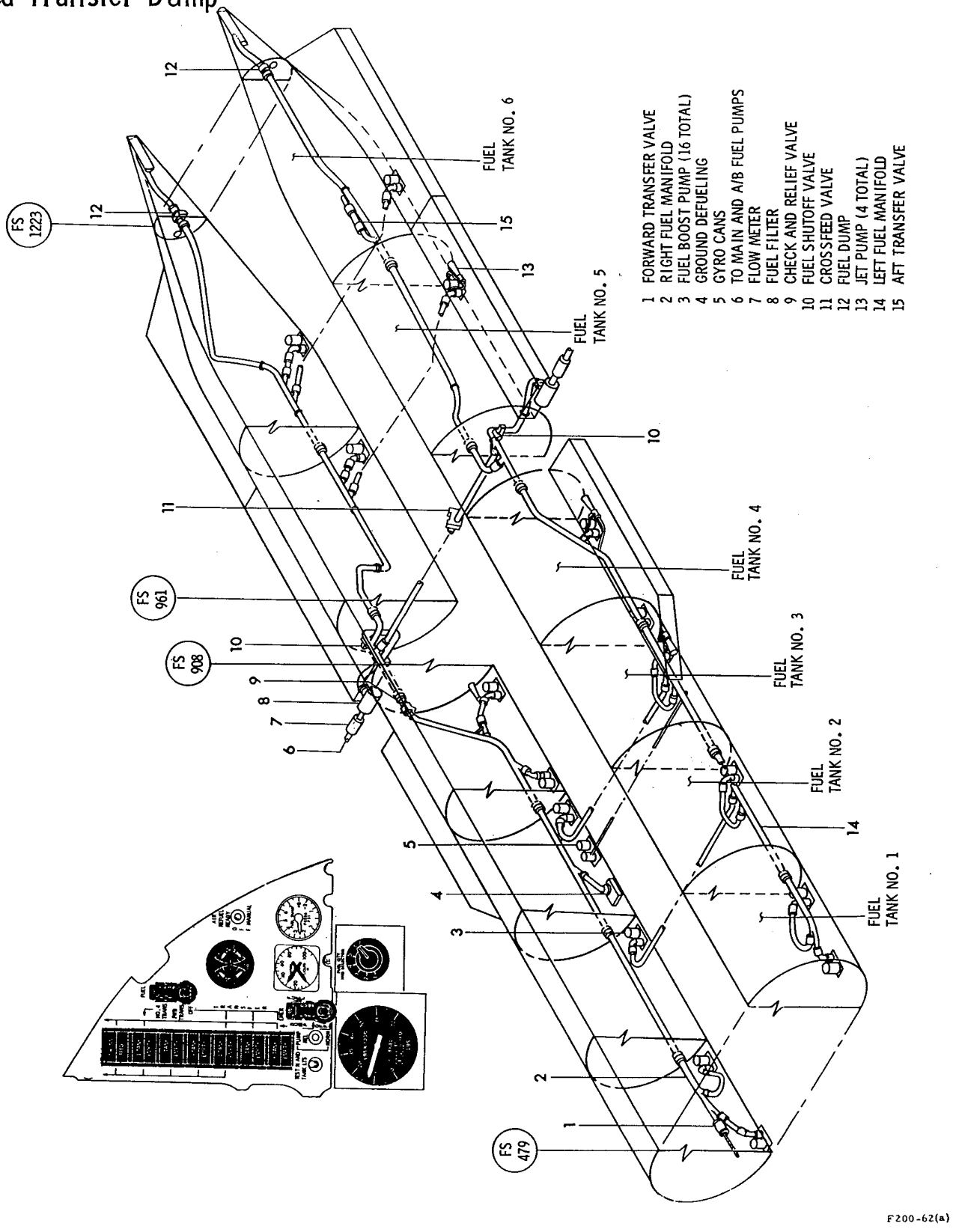


Figure 1-13

matic tank sequencing if a tank fails to feed in the proper sequence. It is necessary to actuate the pump release switch to terminate the manually actuated pumps when the tank is empty. Normally, each pump (except pumps 1-1 and 1-2 which are protected by a common float switch) is protected by a float switch that deactivates the pump when the tank is empty. One of the float switches in each tank illuminates the yellow tank empty light contained in the respective boost pump tank switch. For example, the float switch for the number 4 pump in tank 4 is used to indicate that tank 4 is empty and pump 4-4 is off. (The tank 4 light indicates green when pumps 4-3 and/or 4-4 are on. When pump 4-4 is on and in automatic sequencing, the green light may not indicate the status of other tank 4 pumps whose operation is affected by automatic features of the ullage and refueling systems.) The boost pumps that feed the left hand manifold are normally powered from the left generator bus and the pumps that feed the right hand manifold are normally powered from the right generator bus. Individual circuit breakers for each pump are located in the compartment behind the cockpit and are not accessible in flight.

Emergency Fuel Shutoff Switches

A guarded fuel shutoff switch for each engine is installed on the lower right side of the instrument panel. Each switch is guarded in the down (fuel on) position. Fuel is shut off in the OFF (up) position. Movement of a switch causes a motor operated valve in the respective engine feed line to operate. Motor power is supplied from the corresponding ac generator bus.

Fuel Boost Pump Switches and Indicator Lights

Six pushbutton type fuel boost pump switches with green and yellow indicator lights are installed in a vertical row on the right side of the instrument panel. These switches are provided for manual control of the fuel boost pumps.

NOTE

Manual operation supplements, but does not terminate the normal automatic fuel tank sequencing.

The switches have an electrical hold and bail arrangement that allows manual selection of only one tank of tank group 1, 2, 3 and one tank of tank group 4, 5, 6 at the same time. This feature is intended to prevent more than eight boost pumps from operating simultaneously.

NOTE

It is possible to operate more than eight boost pumps at once by a combination of automatic sequencing and manual actuation; however, this condition will not overload the electrical system except when operating on a single generator.

When a set of boost pumps is actuated, either automatically or manually, a green light will illuminate in the pushbutton. When a tank is empty, a yellow EMPTY light in the pushbutton illuminates. When depressed the boost pump switch will hold down electrically until released by the pump release switch. Power for the boost pump switch circuit and lights is furnished by the essential dc bus.

Pump Release Switch

A momentary pump release switch is installed on the instrument panel below the fuel boost pump switches. The switch has two positions, PUMP REL (up) and NORM (down). When placed in the momentary PUMP REL position, any boost pump switch that has been depressed during

manual boost pump selection will be released and automatic sequencing of the fuel tanks is continued. Power for the circuit is furnished by the essential dc bus.

CAUTION

A manually selected boost pump should be released when a tank indicates empty so that the pumps in that tank will be shutoff; otherwise, damage to the pump may occur.

Crossfeed Switch

A pushbutton type crossfeed switch is located above the boost pump switches on the instrument panel. When depressed, it illuminates a green light in the switch, opens a motor operated valve between the left and right fuel manifolds, allowing operating boost pumps to pressurize both fuel manifolds. The switch must be depressed a second time to terminate crossfeeding. Power for the circuit is furnished by the essential dc bus.

Fuel Transfer Switch

A guarded three-position fuel transfer switch is located on the right side of the instrument panel. The switch is guarded in the OFF position. When the guard is raised and the switch is moved to the FWD TRANS position, the pumps in tank 1 are inactivated, a valve at the forward end of the right fuel manifold opens into tank 1 if fuel manifold pressure is above approximately 8 psi and fuel will transfer forward through the right side fuel manifold as long as automatic or manual pump sequencing continues. Transfer will be automatically terminated by closing of the forward transfer valve when the tank 1 fuel level reaches 4000 pounds. Tank 1 boost pumps will remain inactivated until either tank 4 has approximately 800 lbs remaining or the transfer switch is moved to the OFF (down) position. Tank 1 pumps will also start when the tank 1 pump switch is pressed. The forward transfer valve is not closed by manual selection of tank 1 but right side boost pump pressure makes forward transfer ineffective. The lift-lock forward transfer switch may also be pulled out and placed in the NO. 4 TRANS position. In this position, tank 1 pumps are inactivated, the right side pumps in tank 4 are turned on, and tank 5 is turned off if operative. The transfer is only from tank 4, which prevents the accumulation of hot fuel in tank 4 and puts the warmer fuel into tank 1 where it will be used immediately after an air refueling.

NOTE

Forward transfer should be discontinued before refueling is started to restore normal tank sequencing.

Transfer is automatically terminated when the tank 1 4000 pound float switch operates, and the tank 1 pumps remain off until either tank 4 has 800 pounds remaining or the transfer switch is moved to the OFF position. Power for the transfer control circuits is furnished by the essential dc bus.

Those aircraft incorporating S/B 1141 are modified to replace the Tank 4 Forward Transfer position with an EMER forward transfer position on these aircraft. When the lift-loc switch is pulled out and replaced in the EMER position, tank 1 pumps are inactivated and the dual 4000 lb stop transfer float switches in tank 1 are replaced by dual 7400# float switches. This allows forward transfer to continue until tank 1 is full.

WARNING

The EMER position is to be used only in case of an aft c.g. emergency.

Fuel Dump Switch

A guarded 3-position lift-lock fuel dump switch is located on the right side of the instrument panel. The switch is guarded in the OFF (down) position. In the DUMP (center) position dual type solenoid dump valves in each manifold are opened and the pumps in tank 1 are inactivated unless selected manually. If fuel pressure is above 10 psi, all other tanks dump in normal usage sequence until tank 4 is down to a 8000 pound remaining level. Dumping nor-

mally stops at this point and, if fuel is in tank 1, the tank 1 pumps will start unless the forward transfer switch is in either the FWD TRANS or NO. 4 TRANS position. The switch knob must be pulled out to put the switch through the DUMP position either to the EMER or OFF position. In the EMER position, the 8000 pound stop dump switch in tank 4 is bypassed and fuel dumping will continue from all tanks except tank 1. If tank 4 is to be completely dumped, tank 1 should be pressed on before tank 4 empties in order to avoid fuel pressure fluctuation as tank 4 empties. Power for the circuit is furnished by the essential dc bus.

WARNING

Emergency fuel dumping must be terminated by placing the dump switch to DUMP or OFF. All fuel can be dumped with EMER dump on and tank 1 selected manually.

Fuel Quantity Selector Switch and Quantity Indicator

A fuel quantity indicator and a rotary seven-position fuel quantity selector switch is installed on the lower right side of the instrument panel. Positions on the selector switch are marked for TOTAL and each of the six tanks positions. The switch is rotated to the individual tank or TOTAL position to select the desired reading on the fuel quantity indicator. The dial is calibrated in 5000 pound increments from zero to 70,000 pounds. The indicator has a digital readout window indicating to the nearest 100 pounds. Power for the circuit is furnished by the No. 1 inverter.

Fuel Quantity Low Light

A FUEL QTY LOW light on the annunciator panel will illuminate when total fuel remaining in tank 4 is 5000 pounds or less. Power for the light is furnished by the essential dc bus.

Fuel Pressure Low Warning Lights

Fuel pressure warning lights, labeled L and R FUEL PRESS LOW are located on the annunciator panel. Illumination indicates that engine fuel inlet pressure has fallen below approximately 7 $\pm$ 0.5 psi. The light is extinguished by restoring fuel pressure above approximately 10 psi. Power is furnished by the essential dc bus.

NOTE

It is possible for a fuel pressure low warning light to illuminate when only two fuel pumps are feeding an engine during high fuel flows, especially with forward transfer and/or fuel dump selected.

Test N and Tank Lights Switch

A test N and tank lights switch is installed below the boost pump switches on the instrument panel. The switch has two positions, up and down (spring loaded down) and is used to test the operation of the liquid nitrogen indicators, nitrogen system annunciator light, derichment light and fuel boost pump lights. When the switch is moved to the up position, the liquid nitrogen indications will move down-scale toward zero and the N QTY LOW annunciator light, fuel boost pump lights and derichment light will illuminate. Power for the circuit is furnished by the essential dc bus.

FUEL SYSTEM
Pressurization

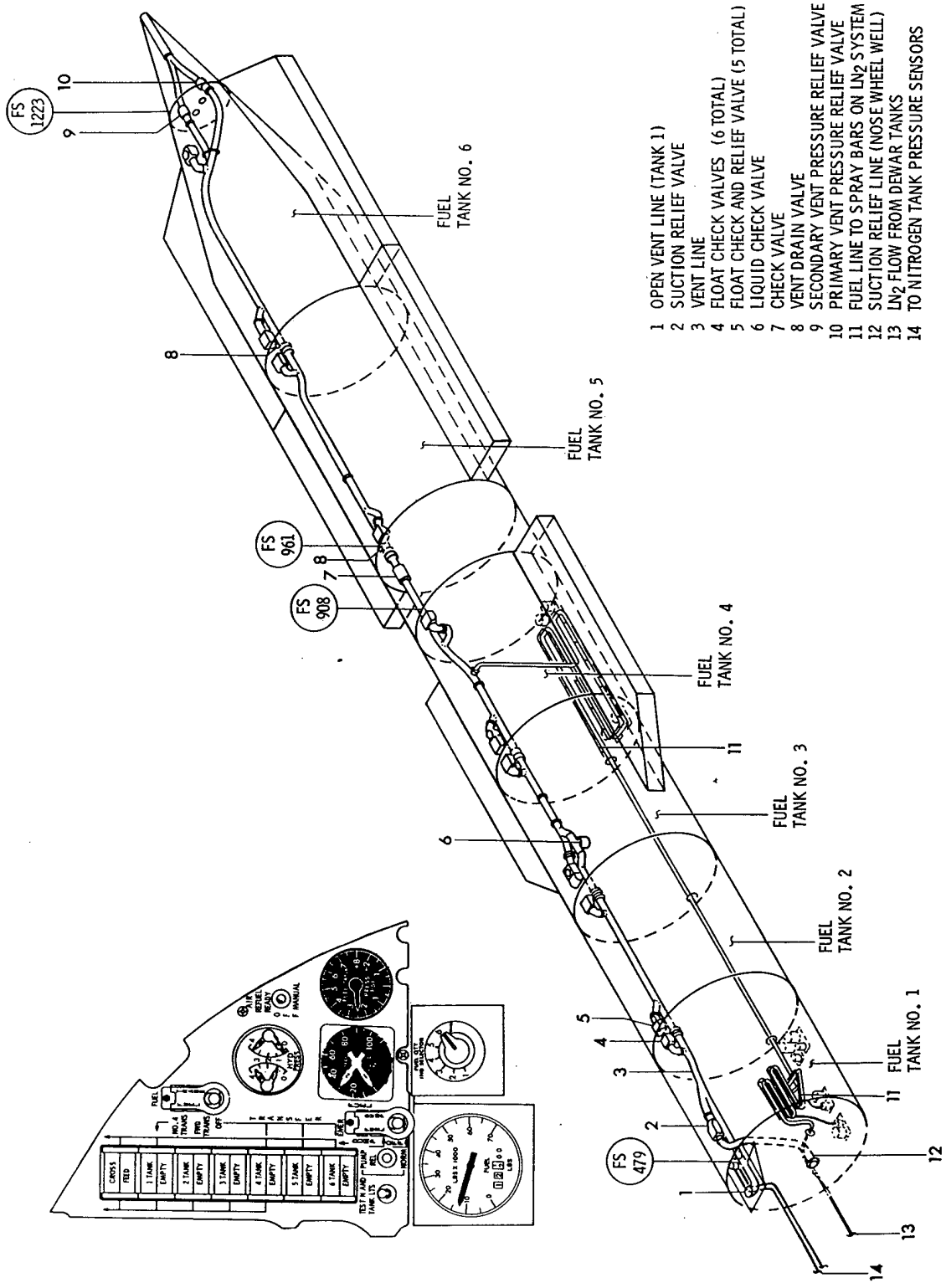

1 OPEN VENT LINE (TANK 1)
2 SUCTION RELIEF VALVE
3 VENT LINE
4 FLOAT CHECK VALVES (6 TOTAL)
5 FLOAT CHECK AND RELIEF VALVE (5 TOTAL)
6 LIQUID CHECK VALVE
7 CHECK VALVE
8 VENT DRAIN VALVE
9 SECONDARY VENT PRESSURE RELIEF VALVE
10 PRIMARY VENT PRESSURE RELIEF VALVE
11 FUEL LINE TO SPRAY BARS ON LN2 SYSTEM
12 SUCTION RELIEF LINE (NOSE WHEEL WELL)
13 LN2 FLOW FROM DEWAR TANKS
14 TO NITROGEN TANK PRESSURE SENSORS
FUEL TANK NO. 6
FUEL TANK NO. 5
FUEL TANK NO. 4
FUEL TANK NO. 3
FUEL TANK NO. 2
FUEL TANK NO. 1
FS 1223
FS 961
FS 908
FS 479
F200-64(b)

Figure 1-14

FUEL PRESSURIZATION AND VENT SYSTEM

The fuel pressurization system consists of two Dewar flasks, located in the nosewheel well, and associated valves and plumbing to the fuel tanks and indicators. These flasks are equipped with automatic ac powered heaters and contain liquid nitrogen. The forward flask contains 75 liters and the aft flask contains 106 liters. They supply nitrogen gas to the fuel tanks at 1.5 $\pm$ .25 psi above ambient pressure. This inerts the ullage space above the fuel and will produce some fuel flow to the engine-driven pump in case of boost pump failure. The liquid nitrogen from the bottom of the flasks is routed through submerged heat exchangers in tanks 1 and 4 to ensure that the nitrogen has become gaseous. The nitrogen gas is then ported to the common vent line and to the top of all tanks.

The venting system consists of a common vent line through all tanks with two vent valves in each tank except the No. 1 tank which has only one vent valve and the open forward end of the vent line. The forward vent valve in tanks 2 through 6 is equipped with a relief valve to relieve tank pressure at 1.5 psi, and a float valve that closes the vent valve when the tank is full. The float shutoff is provided to keep fuel from entering the vent line. The aft vent valve is similar to the forward except it has no relief valve. The common vent line tees into two lines in tank 6 and both go through the rear bulkhead. In the tail cone area there is a relief valve in each line with the left valve set to relieve pressure at 3.25 $\pm$ .25 psi above ambient pressure. In the event of failure of this valve, the right valve will relieve pressure at 3.85 to 4.15 psi. A suction relief line and valve connects to the common vent line in tank 1 and terminates in a bell mouth fitting in the aft end of the nosewheel well.

Two valves are provided in the vent system to prevent fuel from surging forward in the vent line during aircraft deceleration. A check valve prevents fuel that is coming forward from tank 6 from going farther than tank 5. A python valve located in tank 3 prevents fuel coming from tank 4 from going any farther than tank 3. This float actuated valve closes the vent when fuel is moving forward in the vent line and diverts it into tank 3. Acceleration presents no problem of fuel shift between tanks.

Liquid Nitrogen Quantity Indicator

A dual liquid nitrogen quantity indicator is installed on the right side of the instrument panel. The indicator displays the quantity of liquid nitrogen remaining in each of the two dewar flasks. The indicator is marked in 5 liter increments from 0 to 110 liters. Power for the indicator is furnished by the No. 1 inverter bus.

N2 Quantity Low Light

An indicator light labeled N QTY LOW is provided on the annunciator panel. The light will illuminate when either hand on the liquid nitrogen quantity gage reaches 1 liter remaining. Power for the light is furnished by the essential dc bus.

Fuel Tank Pressure Indicator

A fuel tank pressure indicator is installed on the right side of the instrument panel. The gage indicates the pressure existing in the No. 1 fuel tank, and is marked from -2 to +8 in increments of 1/2 pound per square inch. Power for the indicator is furnished by the 26-volt instrument transformer.

FUEL HEAT SINK SYSTEM

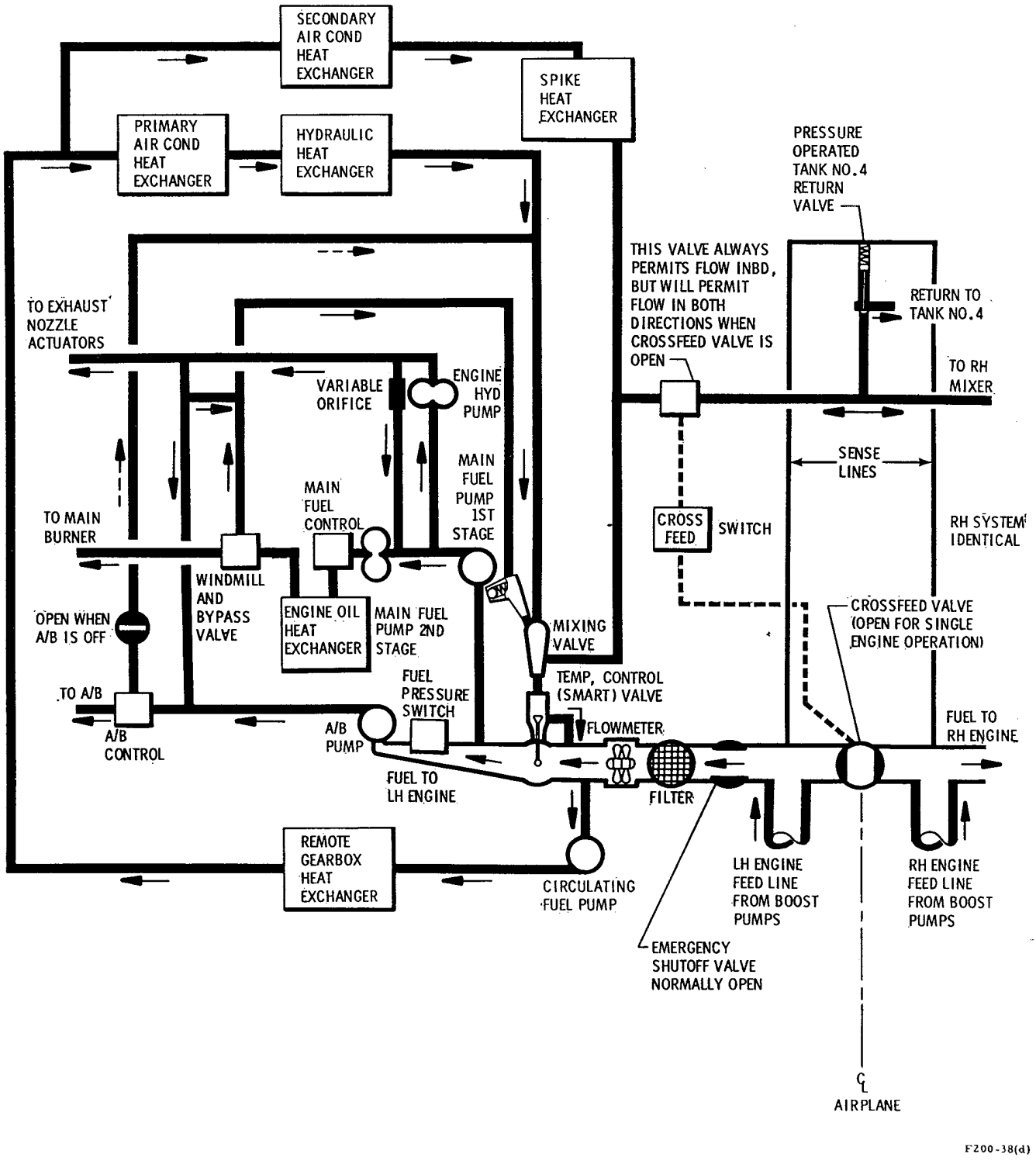


Figure 1-15

Tank Pressure Low Light

A TANK PRESSURE LOW warning light is located on the annunciator panel and will illuminate when the tank pressure reduces to +.25 to +.10 psi. Power for the light is furnished by the essential dc bus.

FUEL HEAT SINK SYSTEM

Fuel from the fuel manifolds is used as a cooling medium for the air conditioning systems, the aircraft hydraulic fluid, and the engine and remote gear box oil. Circulated fuel from the engine fuel hydraulic system is also used to cool the TEB tank and the control lines which actuate the afterburner nozzle. Engine oil is cooled by main engine fuel flow through an oil cooler, located between the main fuel control and the windmill bypass valve. This fuel is then directed to the main burner section. The other cooling is accomplished by fuel circulation through several cooling loops. Hot fuel returning from the remote gear box heat exchanger, the primary and secondary air conditioning heat exchangers, the hydraulic fluid heat exchanger, the spike heat exchanger and the exhaust nozzle actuators is circulated through a mixing valve and temperature limiting valve (smart valve) and returned to the main engine and afterburner fuel manifold. If the mixed fuel temperature is below 265°F, all of the hot fuel will be burned by the operating engine and afterburner. If the temperature of the mixed cooling loop and incoming engine fuel exceeds 265°F, the smart valve starts to close and a portion of the cooling loop fuel is prevented from mixing with the incoming engine fuel. A pressure operated valve routes the hot fuel to tank 4. The smart valve is completely closed at 295°F and all cooling loop fuel is returned to tank 4. If tank 4 is full, the hot fuel will be diverted to the next tank that has space for it. During single engine operation with the inoperative engine throttle in OFF, actuation of the fuel crossfeed valve also allows the hot recirculated fuel from the windmilling engine to crossover and mix with the cooling loop and incoming fuel for the operating engine.

AIR REFUELING SYSTEM

The aircraft is equipped with an air refueling system capable of receiving fuel at a flow rate of approximately 5000 pounds per minute from a KC-135 boom type tanker aircraft. The system consists of a boom receptacle, doors, hydraulic valves, hydraulic actuators, a signal amplifier and control switches and indicator light. Hydraulic power for the system is normally supplied from the L hydraulic system. If the L hydraulic system is inoperative the refuel system can operate from R hydraulic pressure by selecting alternate steering and brakes. Electrical power is supplied by the essential dc bus.

Air Refuel Switch

An air refuel switch is installed on the right side of the instrument panel. The switch has three positions; READY, OFF and MANUAL. When the switch is placed in the READY (up) position hydraulic actuators open the refueling doors, the boom latches are armed, the receptacle lights illuminate and the green READY light illuminates. The receptacle doors are opened by spring action if hydraulic pressure is not available. In the MANUAL (down) position the latching dogs in the receptacle are closed. They may be opened by holding the disconnect (trigger) switch on the control stick until the boom is seated. When the disconnect switch is released the latches

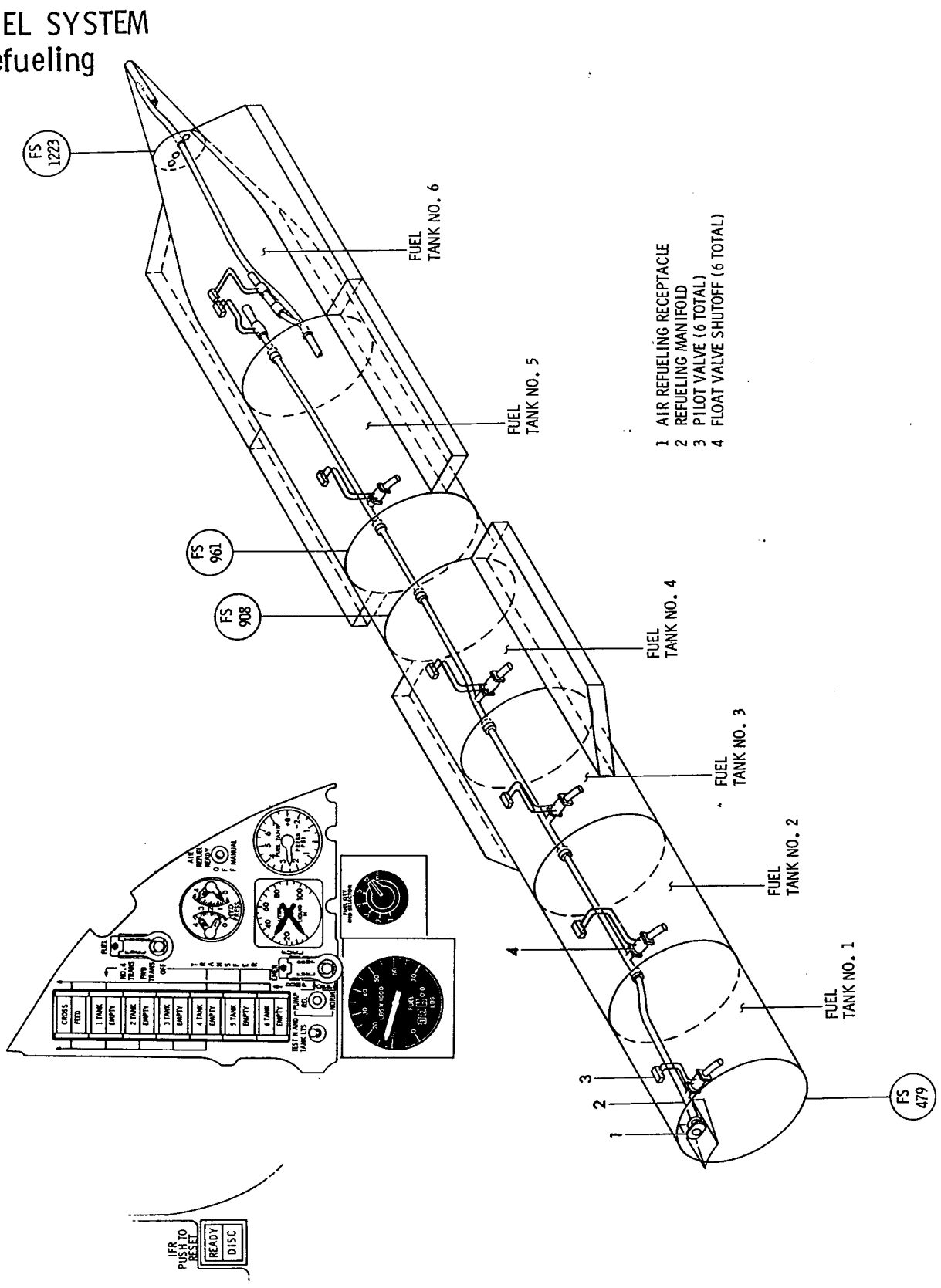

FUEL SYSTEM
Refueling
FS 1223
FUEL TANK NO. 6
FUEL TANK NO. 5
FS 961
FS 908
FUEL TANK NO. 4
FUEL TANK NO. 3
FUEL TANK NO. 2
FUEL TANK NO. 1
FS 479
1 AIR REFUELING RECEPTACLE
2 REFUELING MANIFOLD
3 PILOT VALVE (6 TOTAL)
4 FLOAT VALVE SHUTOFF (6 TOTAL)
IFR PUSH TO RESET
READY
DISC
F200-63(a)

Figure 1-16

will close and hold the boom. The latches will open to release the boom when the disconnect switch is depressed. This position is used in the event of a malfunctioning amplifier. A 3 second time delay is incorporated to prevent nozzle damage if the manual position is selected during refueling contact.

Air Refuel Reset Switch and Indicator Lights

A square dual indicator light and reset button, labeled IFR PUSH TO RESET, is located at the top left side of the instrument panel. The top half is labeled READY and will illuminate green when the air refuel switch is in the READY or MANUAL position, and the refueling receptacle is open and ready to accept the refueling boom. The light will extinguish after the boom is engaged. If the boom disconnects from the fueling receptacle the lower half of the switch will illuminate amber and show DISC. If the air refuel switch is in the READY position the light button is then pressed to reset the system amplifier for another engagement. If the air refuel switch is in the MANUAL position the READY light will be illuminated and manual engagement and disconnect are controlled by the disconnect switch on the control stick. Power for the switch and light is supplied by the essential dc bus.

Disconnect Switch

A momentary contact trigger type switch is installed on the forward side of the control stick. Depressing the trigger switch will normally initiate a disconnect. The disconnect switch is also depressed to open the receptacle latches when the air refuel switch is in the MANUAL position. Releasing the disconnect switch will close the latches.

Disconnect

A disconnect may be accomplished in four ways:

1. Automatically, if boom envelope limits are exceeded (except when using manual boom latching).
2. Automatically, when manifold pressures reach 100 $\pm$ 5 psi.
3. Manually, by the boom operator.
4. Manually, by actuating the disconnect switch on the control stick.

Pilot Director Lights (Tanker)

Pilot director lights are located on the bottom of the tanker fuselage between the nose gear and the main gear. They consist of two rows of lights; the left row for elevation and the right row for boom telescoping. The elevation lights consist of five colored panels with strip green, triangular green and triangular red colors and two illuminated letters, D and U, for down and up respectively. Background lights are located behind the panels. The colored panels are illuminated by lights that are controlled by boom elevation during contact. The colored panels that indicate boom telescoping are not illuminated by background lights. An illuminated white panel between each colored panel serves as a reference. The letters A for aft and F for forward are visible at the ends of the boom telescoping panel. The Air Refueling Director Lights Profile (Figure 2-5) shows the panel illumination at various boom nozzle positions within the boom envelope. There are no lights to indicate azimuth; however, a yellow line is visible on the tanker to indicate the centered position. When contact is made, the panels automatically reflect the correction the pilot must make to maintain position.

ELECTRICAL POWER DISTRIBUTION

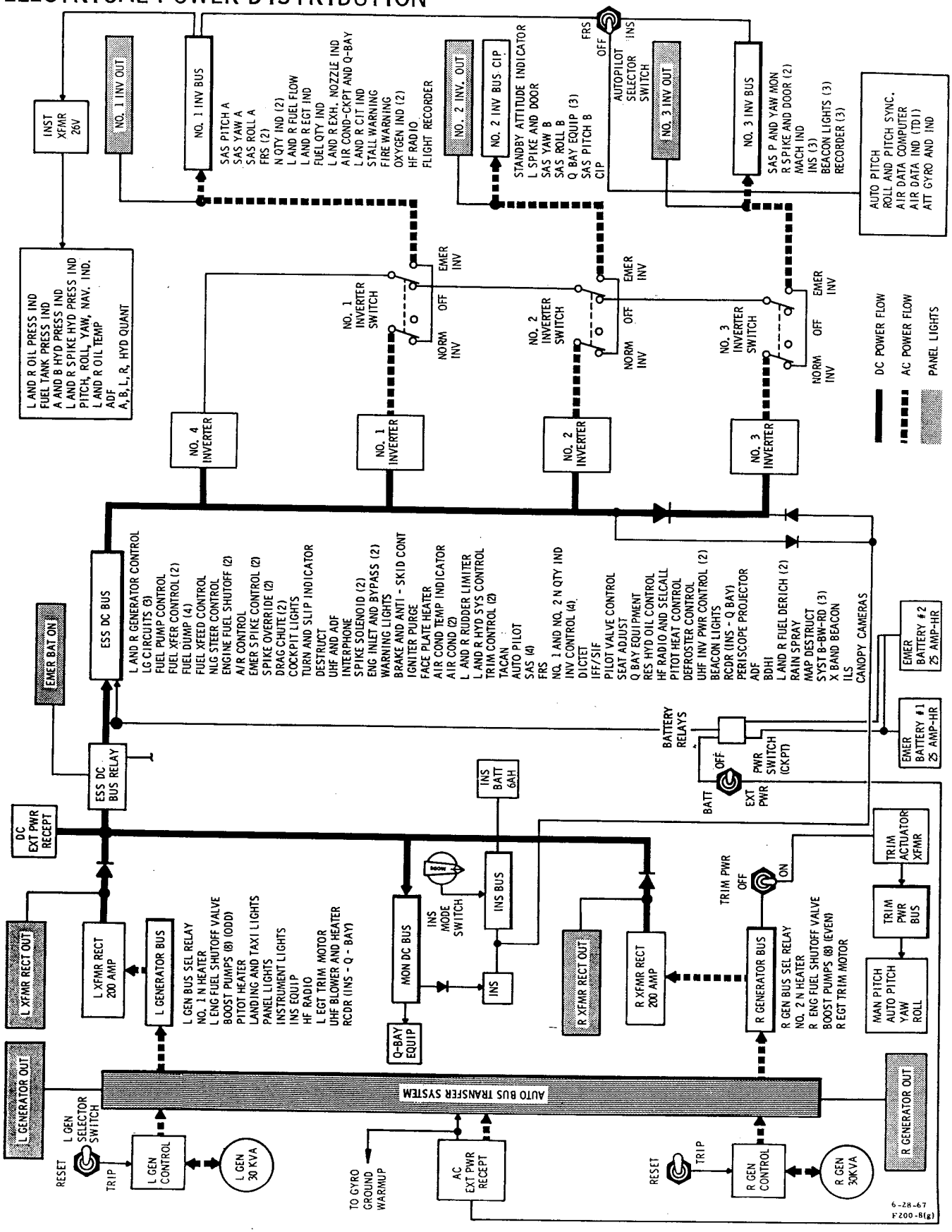


Figure 1-17

ELECTRICAL POWER SUPPLY SYSTEM

Three phase 115/220 volt ac power is provided by two engine driven generators rated at 26 to 32 KVA depending on the installation. Each generator supplies a separate ac bus and a 200 ampere transformer rectifier. Output of the transformer rectifiers is paralleled and furnishes 28-volt ac power to an essential dc bus and a monitored dc bus and to a system of four 600VA inverters. In the event of a single generator failure, a bus transfer and protection system connects the two generator buses. Two 25-amp hour batteries are furnished to supply emergency power to the essential dc bus in the event of complete power failure and a smaller battery provides emergency power to the INS and the No. 3 inverter.

AC ELECTRICAL POWER SUPPLY

Each engine drives an ac generator through its remote gear box to supply 115/200 volt 3-phase power. There are no constant speed drive units, so the ac frequency varies directly with engine rpm; however, the frequency is essentially constant at scheduled engine speed during climb and cruise. When the output of either generator drops below 200 + 5 cps, it is automatically tripped and the other generator automatically provides power through the bus transfer system. Generator cutout occurs at an engine speed of approximately 2800 rpm. Conventional switches are provided for manual control of the generators.

EXTERNAL POWER SUPPLY

The aircraft is equipped with two receptacles for connecting ac and dc external power sources to the aircraft electrical system. These receptacles are located in the nosewheel well. When external power is connected to the aircraft and the power switch is in the EXT PWR position, the ac generators are automatically disconnected from their respective buses and the buses receive power from the ground power unit. External dc power is paralleled with the dc output of the two aircraft transformer rectifiers. External dc power and inverter cooling air must be connected in order for the external ac power to be available.

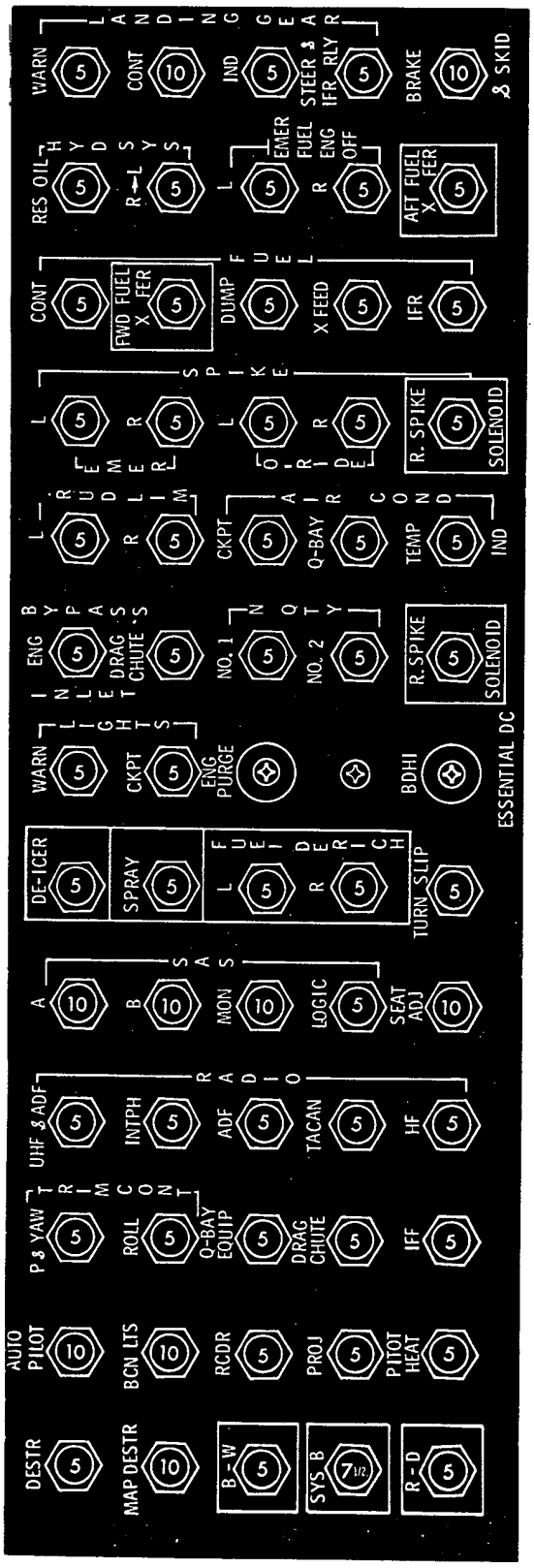
DC ELECTRICAL POWER SUPPLY

Electrical power for the essential and monitored dc buses is normally supplied by the paralleled output of two 200-amp transformer rectifiers which are powered individually by the ac buses. The two 25 ampere-hour emergency batteries are furnished to supply the essential dc bus with power for a limited time when both transformer rectifiers or both generators are inoperative.

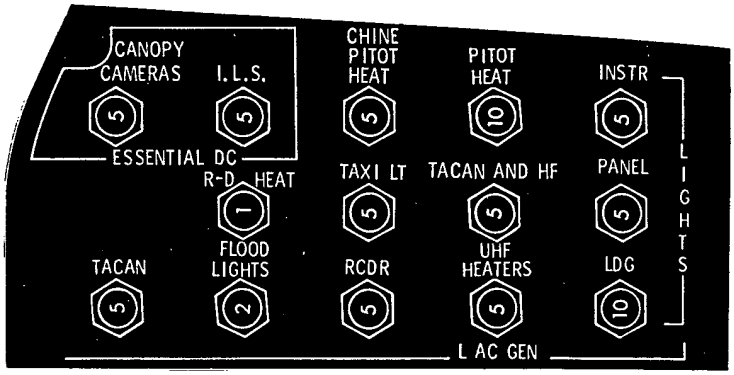
AC INVERTER POWER SYSTEM

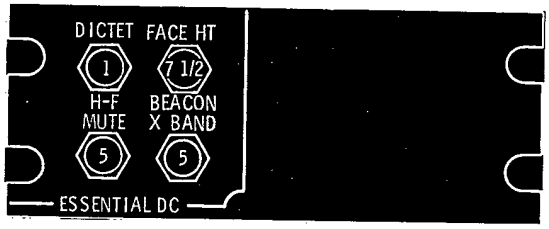
Fixed frequency ac power is supplied by four 600 VA solid state air cooled inverters. These inverters, located in the cheeks of the nosewheel well, are controlled by cockpit switches and powered by the essential dc bus. The No. 3 inverter is also connected to the INS battery whenever the INS mode switch is on. Normally the No. 1, No. 2 and No. 3 inverters furnish power to their respective buses. The No. 4 inverter is normally off. Inverter power distribution is so arranged that the No. 1 inverter bus and its 26-volt instrument transformer powers most of the flight and engine instruments. The No. 3 inverter bus furnishes ac power for the INS. In the event of inverter failure or other electrical system malfunction, any one of the three inverter buses may be operated from the No. 4 in-

CIRCUIT BREAKER PANELS (Typical)

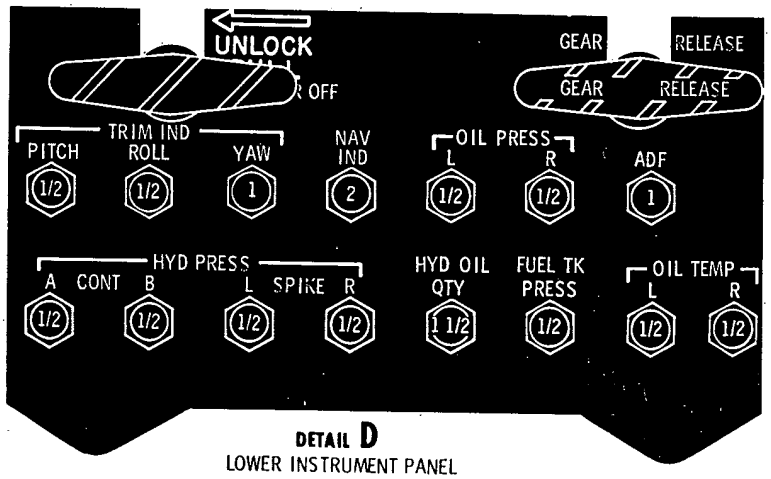


DETAIL C LEFT CONSOLE





DETAIL B
UPPER LEFT

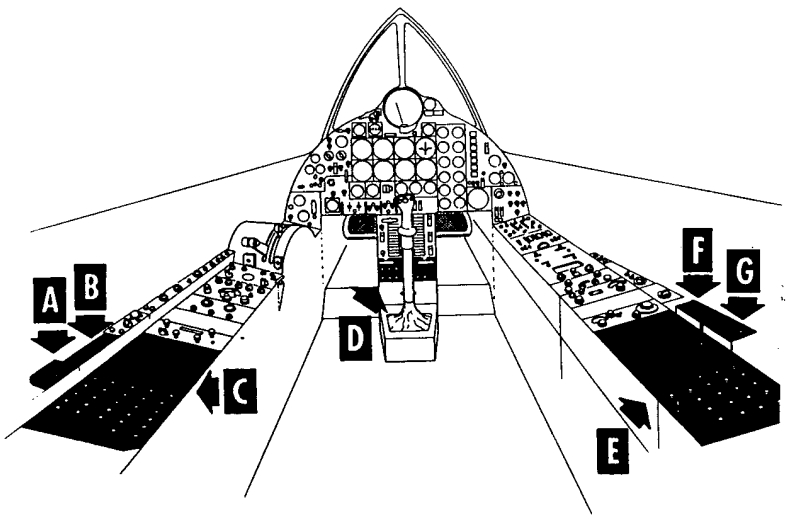


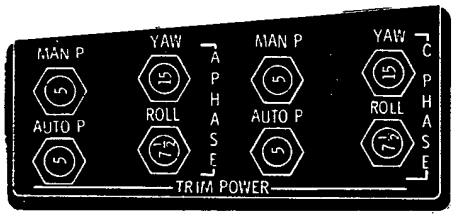
DETAIL D
LOWER INSTRUMENT PANEL

F200-35(1)(g)

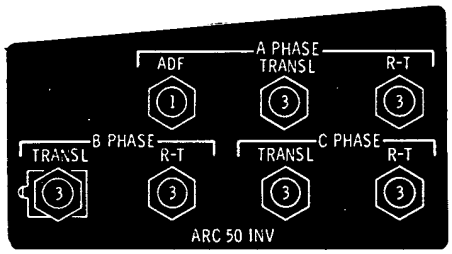
Figure 1-18 (Sheet 1 of 2)

CIRCUIT BREAKER PANELS (Typical)

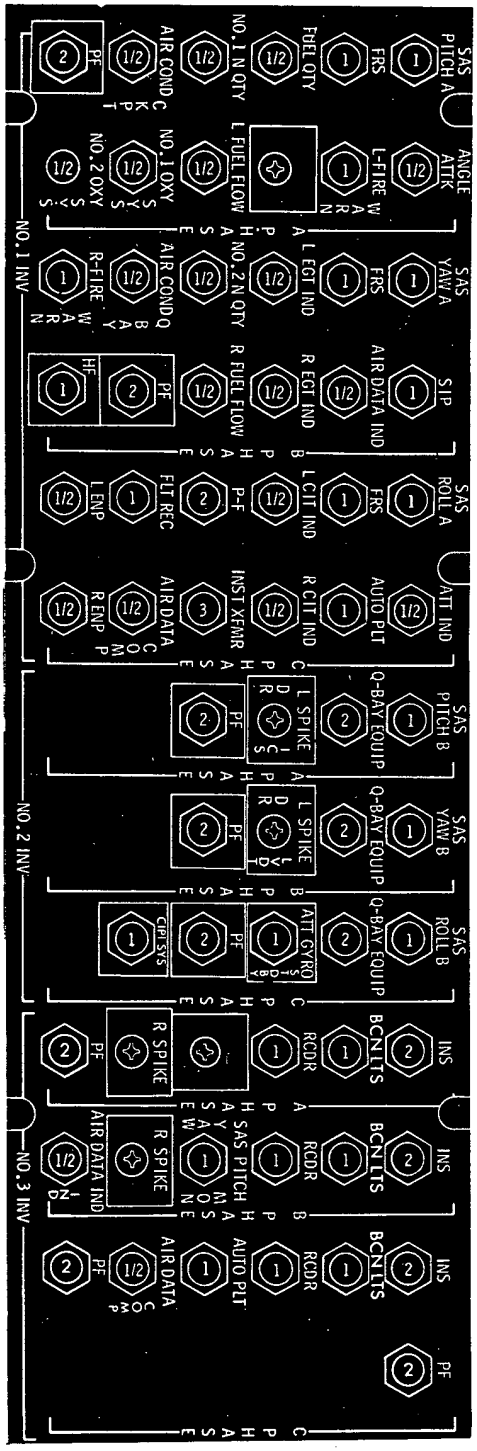




DETAIL F
UPPER RIGHT



DETAIL G
UPPER RIGHT



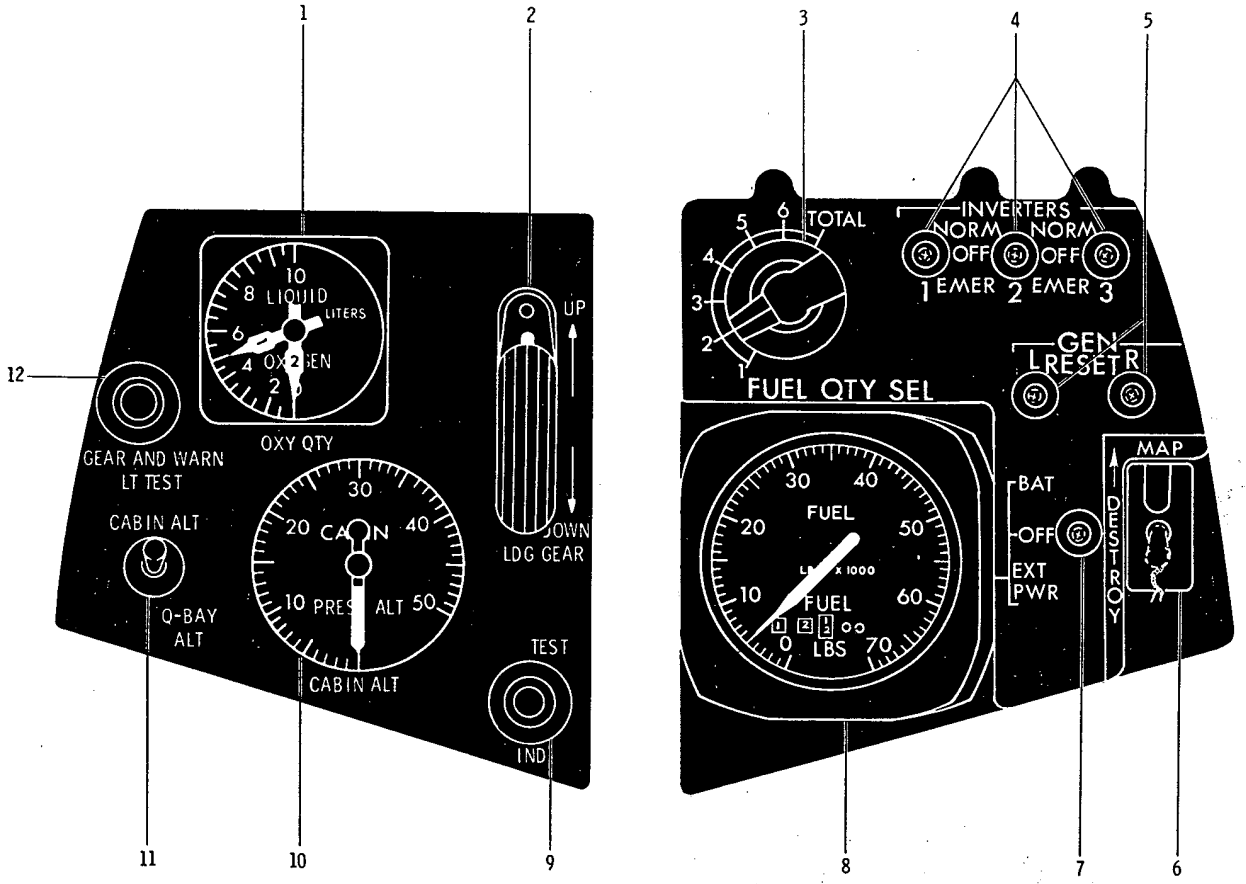
DETAIL E
RIGHT CONSOLE

F200-35(2)(f)

Figure 1-18 (Sheet 2 of 2)

LEFT AND RIGHT FORWARD PANELS

LEFT AND RIGHT FORWARD PANELS



1 OXYGEN QUANTITY GAGE
2 LANDING GEAR LEVER
3 FUEL QUANTITY INDICATOR SELECTOR SWITCH
4 INVERTER SWITCHES
5 GENERATOR SWITCHES
6 MAP DESTROY SWITCH
7 BATTERY SWITCH
8 FUEL QUANTITY INDICATOR
9 CIP AND OXYGEN TEST SWITCH
10 CABIN ALTIMETER
11 CABIN ALTIMETER SELECTOR LEVER
12 GEAR AND WARNING LIGHTS TEST BUTTON

F200-54(1)

Figure 1-19

verter power supply. Certain related equipment is transferred from the No. 1 and No. 3 inverter by operation of the autopilot selector switch to maintain the proper power phase relationships. The AN/ARC 50 UHF radio has its own rotary inverter supply. Refer to Electrical Power Distribution diagram this section.

ELECTRICAL SYSTEM CONTROLS AND INDICATORS

Circuit Breakers

The cockpit circuit breaker panels are located on the right and left consoles and below the annunciator panel. The circuit breakers are push to reset, pullout type breakers for certain ac and dc circuits as listed on the electrical power distribution chart, figure 1-17. Circuit breaker panels which are not accessible during flight, but which should be inspected before flight, are located in the air conditioning bay (just forward of the refueling receptacle) and electrical load center (left hand side of nosewheel well).

Generator Switches

A switch for each generator is located on the right side of the instrument panel and is powered by the essential dc bus. Each switch has three positions; GEN RESET (up), TRIP (down) and center (neutral). The switches are spring loaded to the center neutral position. Holding the switch in the GEN RESET (up) position will return the respective generator to normal operation if it has been removed from the bus for any reason other than complete generator failure. In the TRIP (down) position, the generator output will be removed from the generator bus and the auto bus transfer system will supply that bus from the other generator if it is operating.

NOTE

The generators must be reset and connected to the bus after the engines are started and before the ac ground power is removed.

Power Switch

A three-position battery-external power switch is located on the right side of the instrument panel. When in flight or on the ground with ground power disconnected, placing the power switch in the BAT (up) position causes the emergency batteries to supply power to the essential dc bus. In the EXT PWR (down) position, the external power sources furnish power for the electrical systems. In the center OFF position, external ac power is disconnected but power from the dc external receptacle will continue to supply the essential and monitored dc buses and dc power will not be interrupted by moving the power switch from the EXT PWR to OFF positions.

Inverter Switches

Switches for No. 1, No. 2 and No. 3 inverters are located on the right side of the instrument panel below the generator switches. In the NORM (up) position, the respective inverter is energized and supplies power to its individual bus. In the OFF (center) position the inverter is disconnected from the essential dc bus. In the EMERG (down) position the No. 4 inverter is activated and connected to that inverter bus. In the event of multiple inverter failure, the lowest numbered inverter switch that is placed in the EMERG position receives power from the No. 4 inverter. Under this condition, a higher numbered inverter can not receive power even if its inverter switch is in the EMERG

position. No. 3 inverter also may receive dc power from the small INS battery if the INS mode switch is not in the OFF position.

Generator Out Indicator Lights

The L and R GENERATOR OUT indicator lights, located on the annunciator panel, illuminate when a generator is not furnishing power to its ac bus.

Transformer-Rectifier Out Indicator Lights

The L and R XFMR-RECT OUT indicator lights, located on the annunciator panel, illuminate to indicate that the respective transformer-rectifier is not furnishing power to the dc buses.

Inverter Out Indicator Lights

Three INVERTER OUT indicator lights are located on the annunciator panel. When illuminated, the numbered light indicates that the respective inverter bus voltage is too low. An inverter switch must be placed in the OFF position to disconnect that inverter from the bus. When a disconnected inverter is switched to the EMERG position, the No. 4 inverter is activated and will furnish power to the respective inverter bus and the light will be extinguished unless a lower numbered inverter switch has already been turned to EMERG.

Emergency Battery On Indicator Light

The EMER BAT ON light located on the annunciator panel illuminates when the emergency batteries are furnishing power to the essential dc bus.

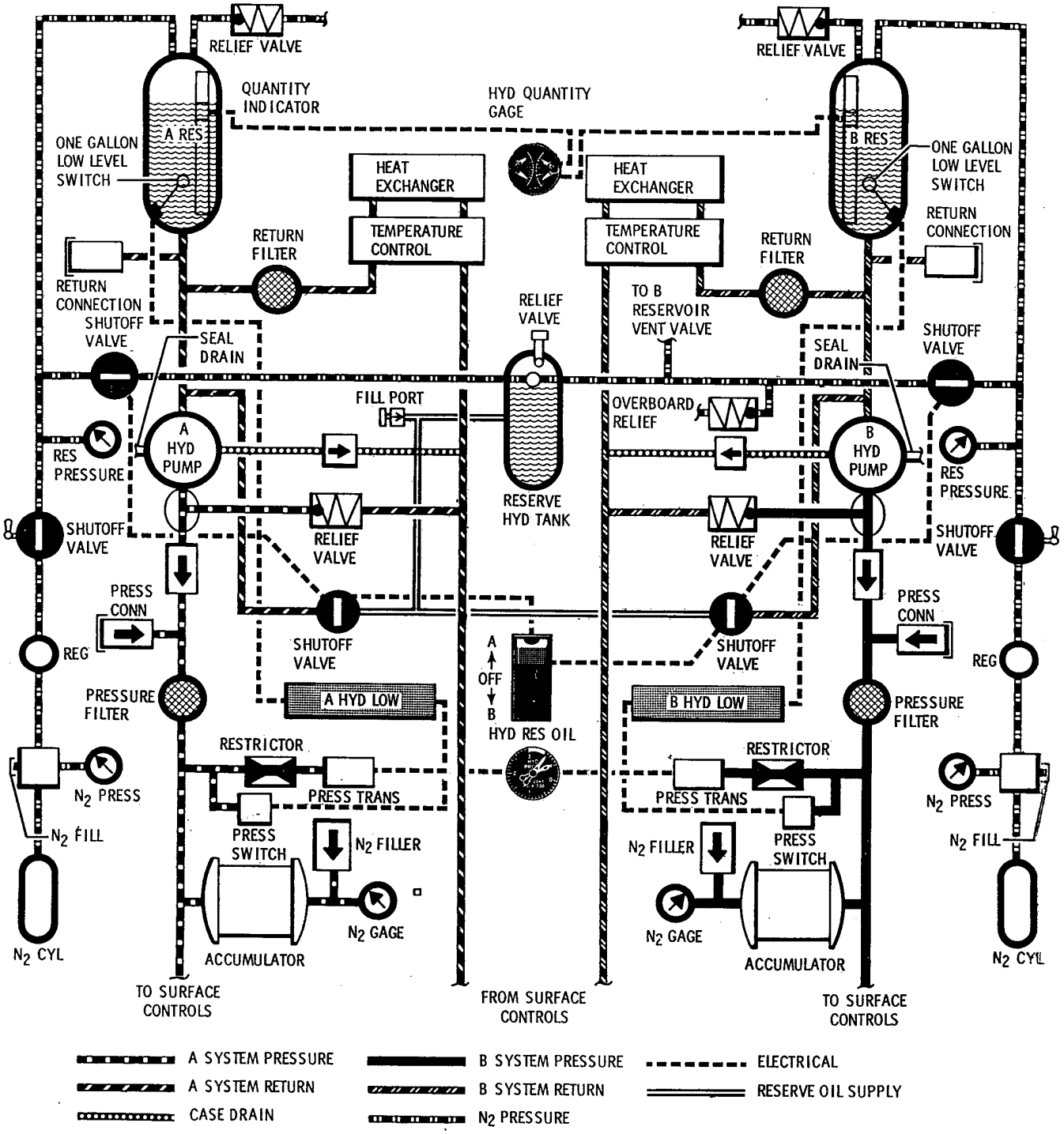
HYDRAULIC POWER SUPPLY SYSTEMS

Four separate hydraulic systems are installed on the aircraft, each with its own pressurized reservoir and engine-driven pump. The pumps for the A and L system are driven from the left engine remote gear box and the B and R system pumps are driven from the right engine remote gear box. Hydraulic fluid is cooled by fuel-oil exchangers, using the aircraft fuel supply as the cooling agent. The A and B hydraulic systems provide power for operating the flight controls. The L and R systems provide power for all other hydraulic requirements of the aircraft. Under normal operating conditions, the systems are independent of one another. The L hydraulic system provides hydraulic power to the left engine air inlet control, the landing gear (including uplocks and door cylinders), normal brakes, in-flight refueling door, UHF retractable antenna, and normal nosewheel steering. The R hydraulic system provides hydraulic power to the right air inlet control and also to the alternate brakes, nosewheel steering, refueling door and landing gear (emergency retraction only) when the L hydraulic system has failed. When the R hydraulic system supplies power to the brakes, the anti-skid feature is inoperative.

Hydraulic System Pressures Gages

Two dual indicating hydraulic gages are installed on the lower center portion of the instrument panel. The right hand gage indicates hydraulic pressure of the A and B (flight controls) systems, and the left hand gage indicates hydraulic pressure of the L and R systems. The gages are calibrated in 100 psi increments from 0 to 4000 psi. Pressure indication on the gages is accomplished by means of remote transmitters in the individual systems. Twenty-six volt ac power is furnished by the instrument transformer and the No. 1 inverter.

A AND B HYDRAULIC POWER SUPPLY SYSTEM



F200-20(e)

Figure 1-20

L AND R HYDRAULIC POWER SUPPLY SYSTEM

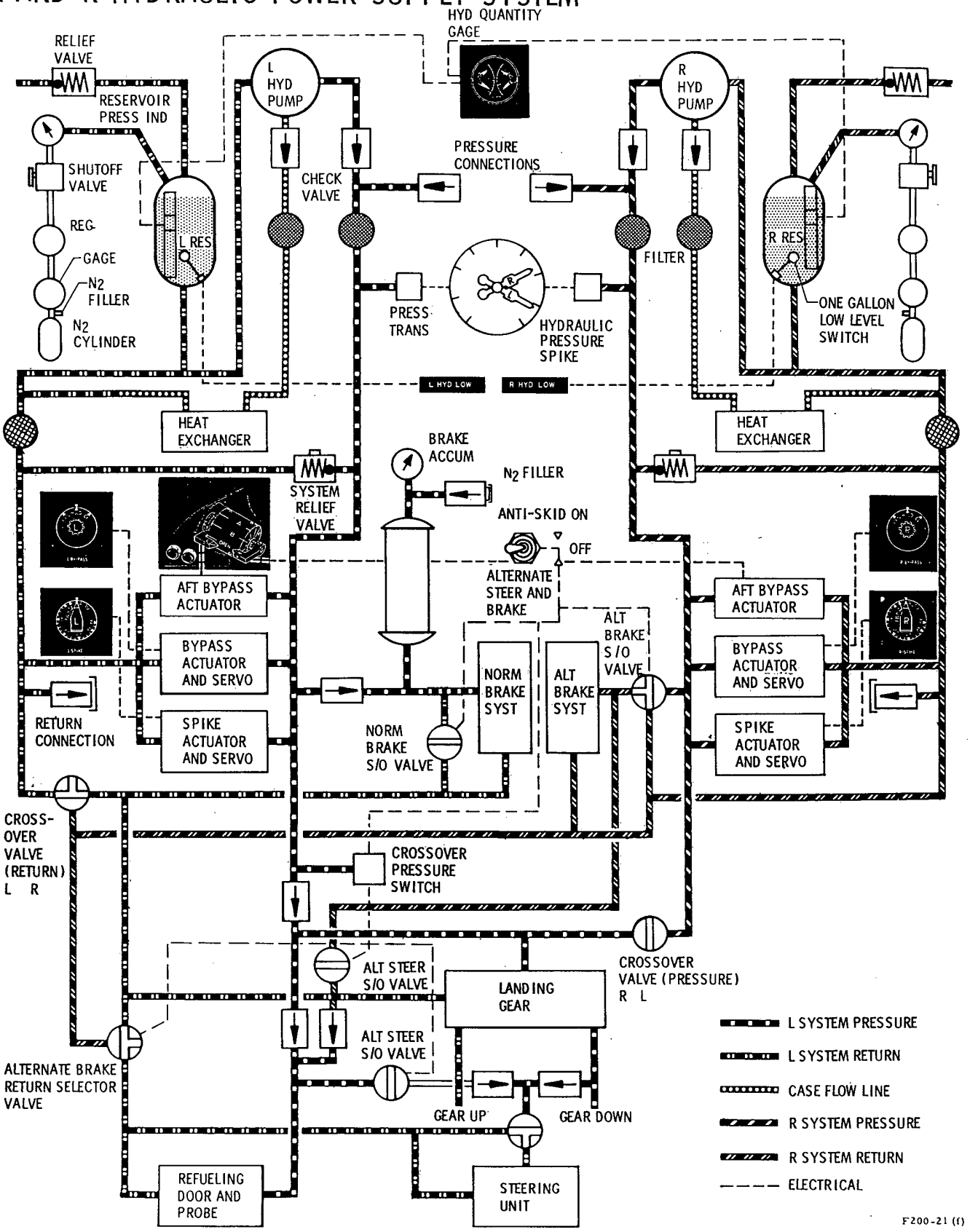


Figure 1-21

Hydraulic Warning Lights

Six hydraulic warning lights are located on the annunciator panel. The A and B HYD PRESS LOW lights will illuminate when the pressure in the respective system drops below 2200 +0 -150 psi. The A and B HYD LOW light will illuminate when the quantity is less than 1-1/4 ± 1/8 gallons. The L and R HYD LOW light will illuminate when the respective reservoir quantity is less than 1-1/4 ± 1/8 gallons. Power for the lights is furnished by the essential dc bus.

Hydraulic System Quantity Gage

A quadruple hydraulic fluid quantity indicator installed on the right side of the instrument panel. The L and R concentric needles are on the left side of the gage and the A & B concentric needles are on the right side of the gage. The dials are marked in gallons. Power is furnished from the 26 V ac instrument transformer.

HYDRAULIC RESERVE OIL SYSTEM

A reserve oil supply for the A and B hydraulic systems is contained in an 8.5 gallon reserve tank mounted in the No. 4 fuel tank. The reserve hydraulic oil is transferred by gravity flow and nitrogen pressure through solenoid operated shutoff valves to either the A or B hydraulic system.

Hydraulic Reserve Oil Switch

The hydraulic reserve oil switch is mounted on the left side of the annunciator panel. It is a three position switch, guarded in the center OFF position. In the A (up) position, solenoid operated shutoff valves are opened to the A hydraulic system suction and tank vent lines. This allows the reserve hydraulic fluid to supply the A system as needed up to approximately 0.3 gallon per minute. In the B (down) position the solenoid valves to the B system are opened and the reserve fluid will supply the B system. Power for the valves is furnished by the essential dc bus.

WARNING

Reserve hydraulic fluid is to be used only to supply the operative A or B system in the event of malfunction of the other system.

FLIGHT CONTROL SYSTEM

The cockpit flight controls consist of a conventional control stick and rudder pedals. The delta wing configuration utilizes elevons instead of separate aileron and elevator control surfaces. The elevons, moving together in the same direction, function as elevators and when moving in opposite directions, function as ailerons. Each elevon consists of an inboard and outboard panel with the inboard panel located between the fuselage and the nacelle and the outboard panel outboard of the nacelle. Both panels on one side function as a single unit with the servo input to the outboard elevon connected directly to the inboard elevon surface. The dual canted rudders are full moving, one piece, pivoting surfaces with a small fixed stub at the junction of the vertical surface and the nacelle. Deflection and control of the elevons and rudders is by means of dual, full hydraulic, irreversible actuating systems.

Control surface travel limits are as follows:

	Elevons	Rudders
Pitch	10° Down 24° Up	-
Pitch plus Roll	20° Down 35° Up	-
Yaw	-	20° Left 20° Right
Roll	12° Down 12° Up	-

FLIGHT CONTROL SYSTEM (Rudders)

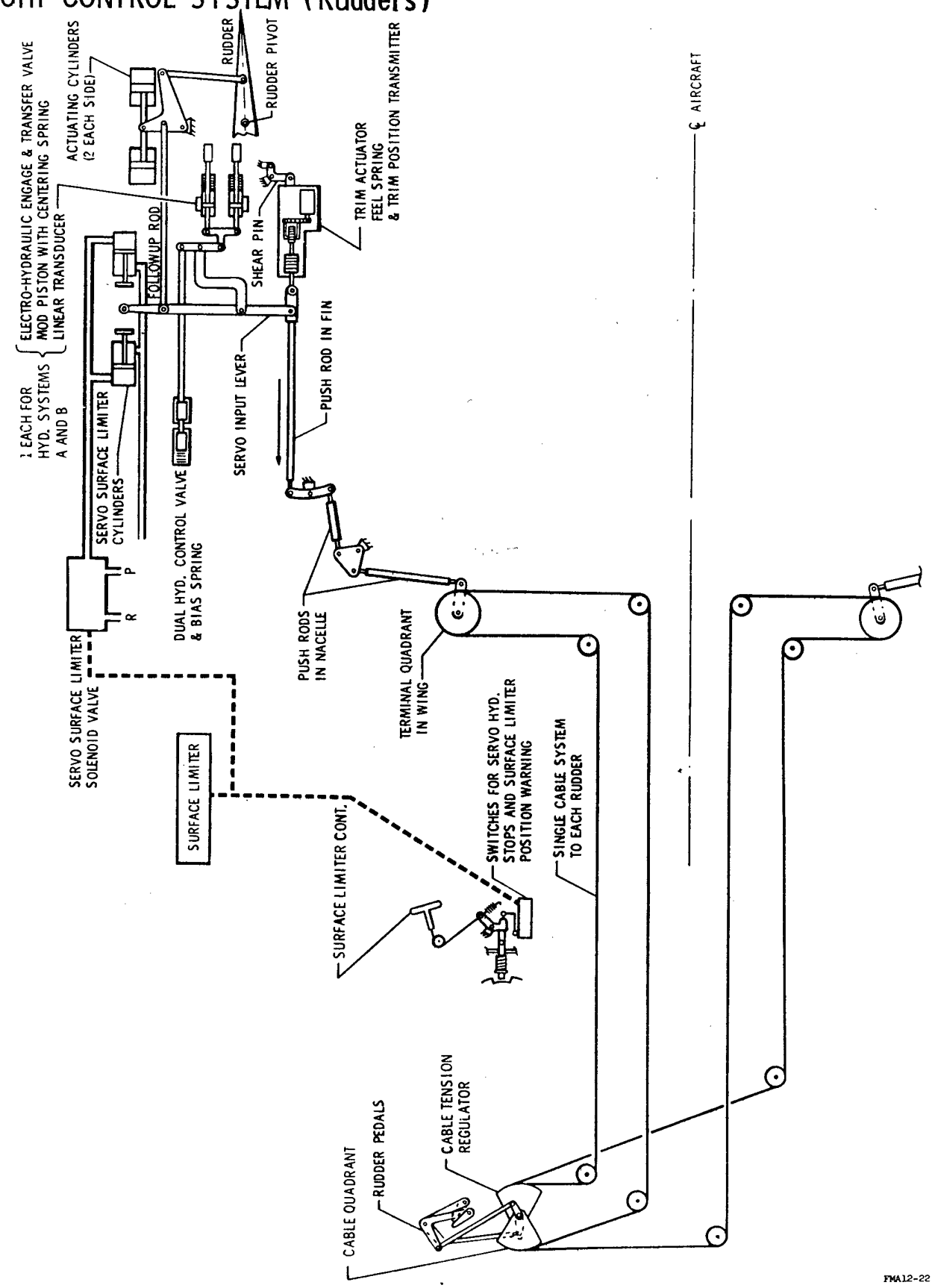

RUDDER
RUDDER PIVOT
ACTUATING CYLINDERS (2 EACH SIDE)
ELECTRO-HYDRAULIC ENGAGE & TRANSFER VALVE MOD PISTON WITH CENTERING SPRING LINEAR TRANSDUCER
1 EACH FOR HYD. SYSTEMS A AND B
TRIM ACTUATOR FEEL SPRING & TRIM POSITION TRANSMITTER
℄ AIRCRAFT
FOLLOWUP ROD
SHEAR PIN
SERVO SURFACE LIMITER CYLINDERS
SERVO INPUT LEVER
PUSH ROD IN FIN
DUAL HYD. CONTROL VALVE & BIAS SPRING
P
R
SERVO SURFACE LIMITER SOLENOID VALVE
PUSH RODS IN NACELLE
TERMINAL QUADRANT IN WING
SURFACE LIMITER
SURFACE LIMITER CONT.
SWITCHES FOR SERVO HYD. STOPS AND SURFACE LIMITER POSITION WARNING
SINGLE CABLE SYSTEM TO EACH RUDDER
CABLE TENSION REGULATOR
RUDDER PEDALS
CABLE QUADRANT
FMA12-22

Figure 1-22

Manually operated mechanical stops are incorporated in the cockpit mechanism to limit the surface movement at high speed. Elevon travel in roll is limited to 7° up, 7° down and rudder travel is limited to 10° right, 10° left. An additional stop is installed in each rudder servo package to limit the rudder travel. These stops are electrically controlled and hydraulically operated by separate electrical and hydraulic systems. If no electrical power is available, the rudders will be limited to approximately 10° L and R travel. If electrical power is available to one stop, that rudder only will have the full 20° L and R travel available. The rudder cable must be stretched to obtain this travel, causing a noticeable increase in rudder pedal force.

CABLE SYSTEM

Cable systems are utilized to transfer control movements from the control stick and rudder pedals to the flight control mechanisms. The pitch and roll axis cable systems are duplicated from the cockpit to the mixing mechanism in the aft fuselage. The rudder system has two separate closed loop single cable systems, one to each rudder. Cable tension regulators and slack absorbers are incorporated in the cable systems.

TRIM CONTROL SYSTEM

Flight control trim is accomplished by deflecting the control surfaces through the use of electrical trim actuators. The roll and pitch trim actuators are located downstream of the feel springs so that stick position remains neutral, irrespective of the amount of trim. The trim actuator and feel spring location is combined in the rudder mechanism and yaw trim is reflected by rudder pedal position.

Travel limits of the trim system are 3-1/2° down to 6-1/2° up in pitch, 4.5° up and down (each side) in roll, and 10° left to 10° right in yaw. Trim position indicators are provided for each axis. Trim rates are as follows:

	Pitch	Roll	Yaw
Max.	1.5°/sec	.95°/sec Total Diff.	1.5°/sec
Min.	0.67°/sec	.47°/sec Total Diff.	0.67°/sec

Automatic pitch trim uses a separate, slow speed motor for autopilot synchronization. The automatic pitch trim rate is 0.15°/sec maximum and 0.067°/sec minimum. Trim power is normally furnished by the R generator bus.

RUDDER PEDALS

Primary control for the rudders consists of conventional rudder pedals mechanically connected by cables, bell cranks and pushrods to hydraulic control valves at the rudder hydraulic actuators. The rudder pedals are released for adjustment by pulling the T-handle labeled PEDAL ADJ located below the annunciator panel. Wheel brakes are controlled conventionally by toe action on the rudder pedals; refer to Wheel Brake System, this section. Rudder pedal movement also controls nosewheel steering; refer to Nosewheel Steering System, this section. The pedals are hinged to fold inboard and upward, providing foot space on the cockpit floor.

A-12

FLIGHT CONTROL SYSTEM (Inboard Elevons)

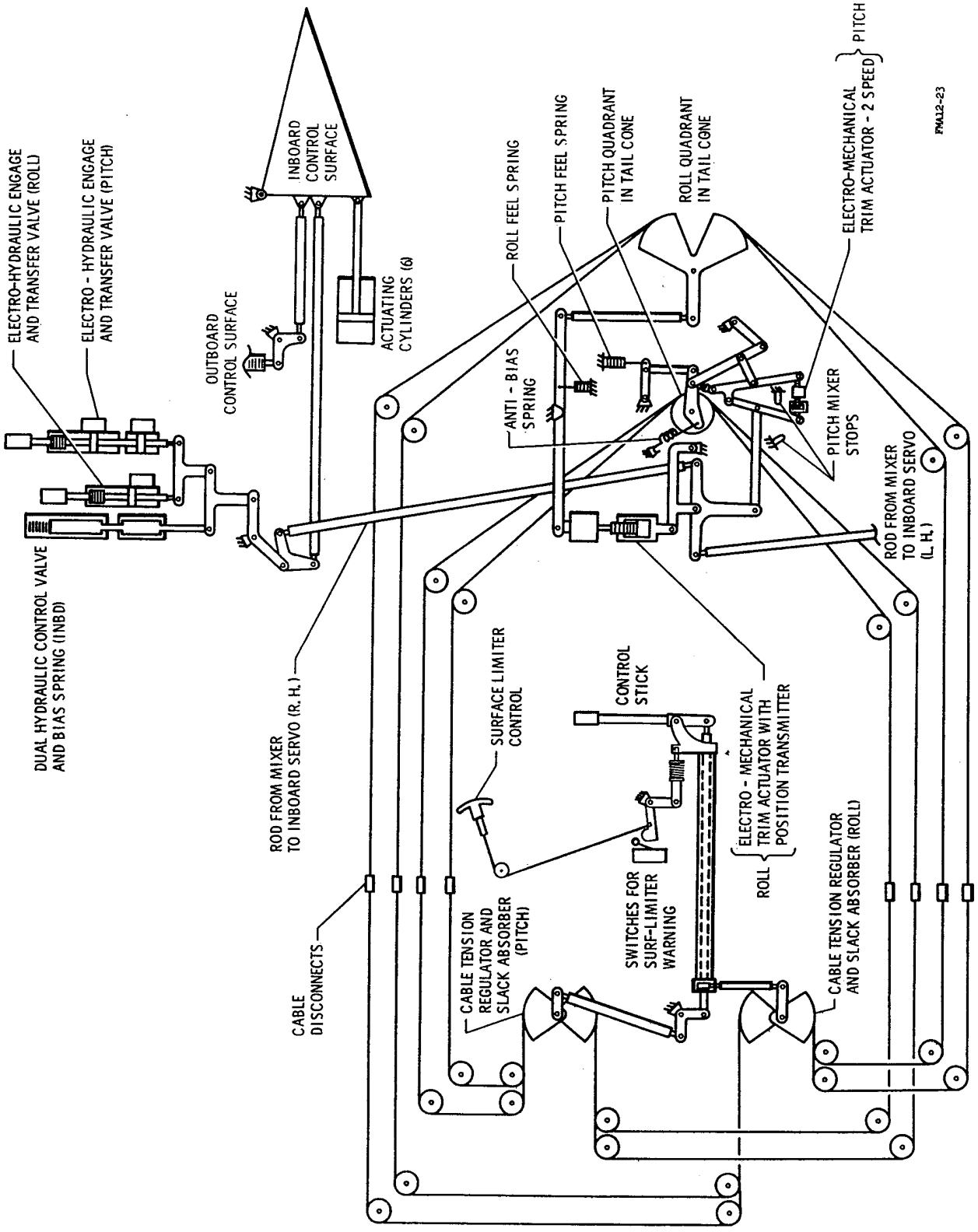
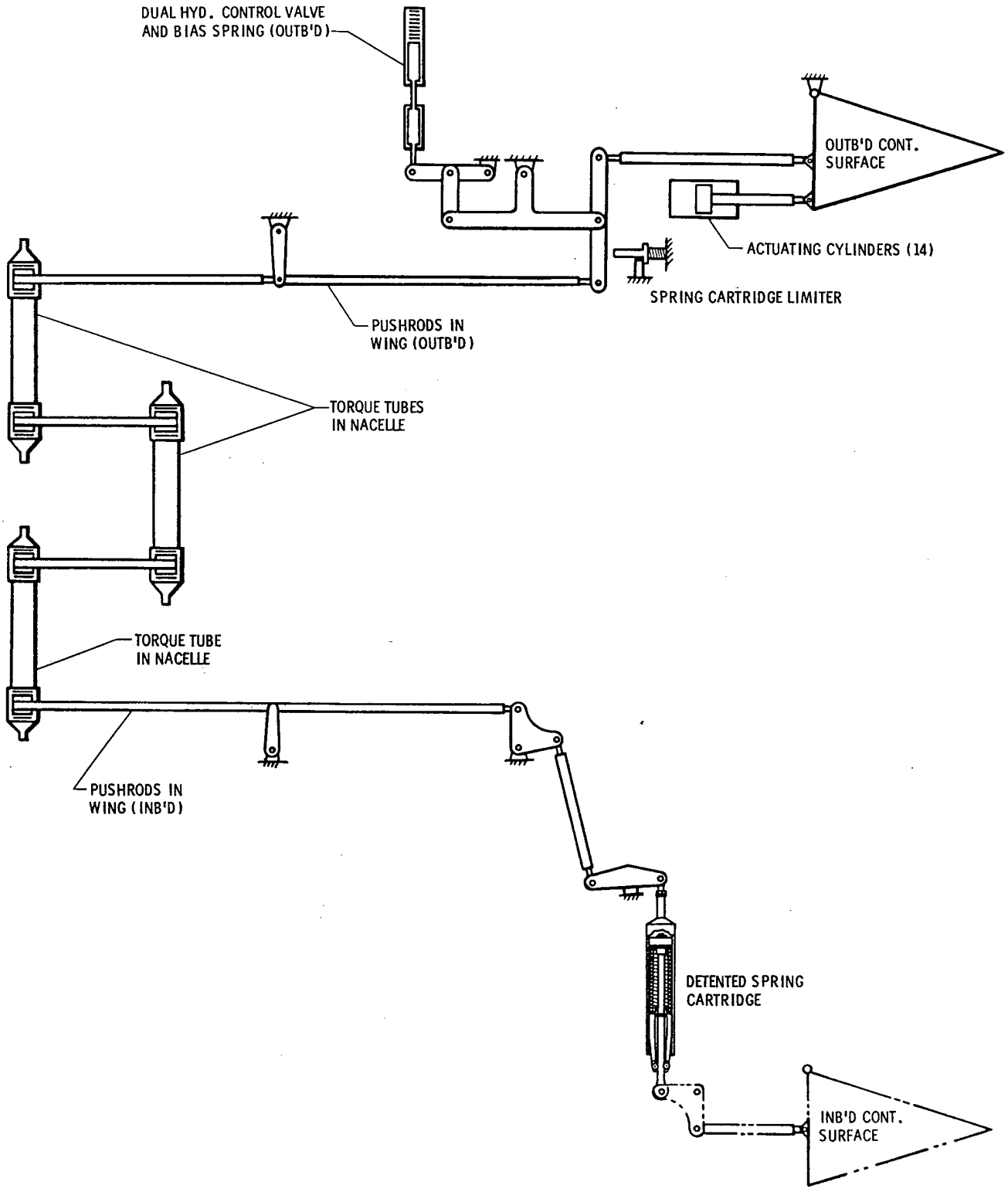

ELECTRO-HYDRAULIC ENGAGE AND TRANSFER VALVE (ROLL)
ELECTRO - HYDRAULIC ENGAGE AND TRANSFER VALVE (PITCH)
DUAL HYDRAULIC CONTROL VALVE AND BIAS SPRING (INBD)
OUTBOARD CONTROL SURFACE
INBOARD CONTROL SURFACE
ACTUATING CYLINDERS (6)
ROD FROM MIXER TO INBOARD SERVO (R. H.)
CABLE DISCONNECTS
CABLE TENSION REGULATOR AND SLACK ABSORBER (PITCH)
SURFACE LIMITER CONTROL
CONTROL STICK
SWITCHES FOR SURF-LIMITER WARNING
ELECTRO - MECHANICAL TRIM ACTUATOR WITH POSITION TRANSMITTER
ROLL
CABLE TENSION REGULATOR AND SLACK ABSORBER (ROLL)
ROLL FEEL SPRING
PITCH FEEL SPRING
ANTI - BIAS SPRING
PITCH QUADRANT IN TAIL CONE
ROLL QUADRANT IN TAIL CONE
ELECTRO-MECHANICAL TRIM ACTUATOR - 2 SPEED
PITCH
PITCH MIXER STOPS
ROD FROM MIXER TO INBOARD SERVO (L. H.)
FM412-23

Figure 1-23 (Sheet 1 of 2)

A-12

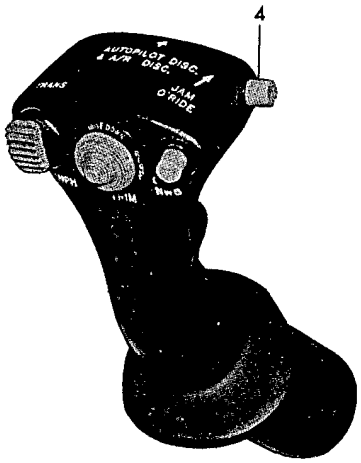
FLIGHT CONTROL SYSTEMS (OUTBOARD ELEVONS)



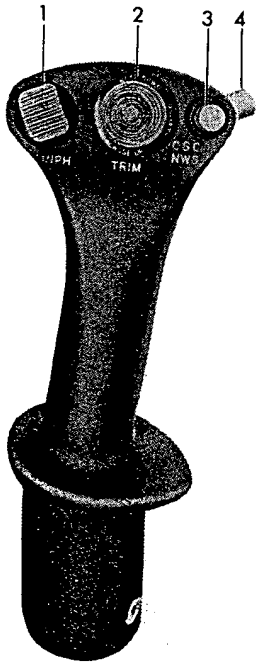
3-30-66
F200-3(a)

Figure 1-23 (Sheet 2 of 2)

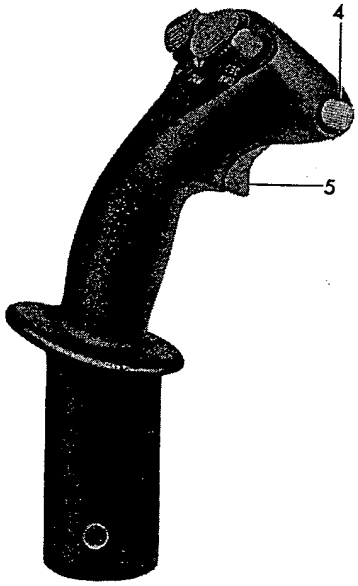
CONTROL STICK GRIP



TOP VIEW



FRONT VIEW



SIDE VIEW

1 TRANSMITTER-INTERPHONE CONTROL SWITCH
2 PITCH AND YAW TRIM SWITCH
3 CONTROL STICK COMMAND-NOSEWHEEL
4 JAM O'RIDE SWITCH
5 EMERGENCY AUTOPILOT DISENGAGE SWITCH AND AIR REFUEL DISCONNECT

F200-24(c)

Figure 1-24

ARTIFICIAL FEEL SYSTEM

The use of a full power irreversible control system for actuation of the surfaces prevents air loads and resulting "feel" from reaching the cockpit controls. Therefore, feel springs are installed in each of the pitch, roll and yaw axis mechanisms to provide an artificial sense of control feel. The springs apply loads to the pilot controls in proportion to the degree of control deflection.

CONTROL STICK

The control stick is mechanically connected by a torque tube, push rods and bell cranks to the dual cable system which operates the roll and pitch quadrants in the aft fuselage tail cone. Mechanical push rod linkages mix the control movements and position dual hydraulic control valves. These valves direct both A and B system hydraulic pressure to the inboard elevon actuating cylinders.

Push rods, bell cranks and torque tubes transfer inboard elevon deflection to position the outboard dual hydraulic control valves. These valves direct both A and B system hydraulic pressure to the outboard elevon actuating cylinders. A push rod followup system closes off the flow of hydraulic fluid to the actuators when the desired elevon deflection is obtained. Located on the control stick grip is a combination pitch and yaw trim switch, an autopilot control stick command, a nosewheel steering button, a microphone switch for both interphone and radio transmission, a combination autopilot disconnect and in-flight refueling disconnect switch and a jam override pushbutton.

Control Stick Command Switch (CSC)

Refer to Autopilot System, Section IV.

Pitch and Yaw Trim Switch

Pitch and yaw trim control is provided by a spring-loaded, four position thumb actuated switch installed on the control stick grip with a center OFF position. The switch positions are LEFT, RIGHT, NOSE UP and NOSE DOWN. The switch controls trim motors powered by the right generator bus through the 28-volt ac trim actuator transformer and trim power bus.

NOTE

The trim power switch must be in the ON position before the pitch, roll and yaw trim switches will operate.

Lateral movement of the switch to the left corrects for right yaw and lateral movement to the right corrects for left yaw. Forward movement of the switch produces down elevon operation of the trim motors and actuators (aircraft nose down). Aft movement moves the elevons up (aircraft nose up).

Trim Power Switch

A trim power ON-OFF switch is located on the annunciator panel. It enables the pilot, if necessary, to disconnect power to all trim motors quickly as the main trim power ac circuit breaker is not available to the pilot. To prevent inadvertent movement the switch must first be pulled out before it can be moved from the ON to the OFF position. In the ON position 200 volt 3 phase ac power from the right generator bus is applied to the primary side of the trim actuator transformer. Individual 28

ac circuit breakers for A and C phases of the Manual Pitch, Auto Pitch, Roll and Yaw trim circuits are located on the right console.

Roll Trim Switch

A three-position roll trim switch is located just forward of the throttle quadrant. The switch positions are indicated by L (left) and R (right) arrows. The switch is springloaded to the center off position. When the switch is held in the R position, the roll trim motor actuates to move the right elevons up and the left elevons down. Actuation of the switch to the L position moves the right elevons down and left elevons up. 28-volt ac power is furnished from the trim power bus.

Rudder-Synchronization Switch

A three-position rudder synchronization switch is installed just forward of the throttle quadrant. The switch positions are indicated by L (left), R (right) arrows. It is springloaded to the center off position. In the L and R positions the switch provides electrical power to the right rudder trim motor which moves the right rudder to agree with the position of the left. Rudder synchronization is obtained by superimposing the L and R needles on the yaw trim gage. 28-volt ac power is furnished by the trim power bus.

Roll, Pitch and Yaw Trim Indicators

Separate roll, pitch and yaw trim indicators are located on the left side of the instrument panel. The roll trim indicator uses a double ended needle and displays the amount of roll trim from 0° to 9° differential. The pitch trim indicator displays the amount of pitch trim from 5° nose down to 10° nose up, although only $3\text{-}1/2^{\circ}$ nose down and $6\text{-}1/2^{\circ}$ nose up trim is available. The yaw trim indicator displays the amount of yaw trim from 10° left to 10° right for both rudders. Rudder synchronization is obtained by superimposing the L and R needles on the yaw trim gage. 26-volt ac power for the indicators is furnished by the instrument transformer and the No. 1 inverter.

Surface Limiter Control Handle

A T-handle, labeled SURF LIMIT RELEASE, is located on the left side of the annunciator panel. When the handle is turned 90° counterclockwise and released, the mechanical stops in the roll and yaw axis of the cockpit control system are activated. This action also opens an electrical switch which de-energizes a solenoid operated valve in each rudder servo package and activates the servo package rudder stops. When the handle is pulled out and rotated 90° clockwise, the mechanical stops in the cockpit are released and the solenoid is energized, releasing the servo package stops. Power for the rudder limiting circuit is furnished by the essential dc bus.

Surface Limiter Indicator Light

When speed exceeds Mach 0.5, an indicator light on the annunciator panel will illuminate until the surface limiter handle is released. If the speed is below Mach 0.5 and the surface limiters are on, the indicator light will illuminate until the surface limiter handle is pulled out. Power for the lights is furnished by the essential dc bus.

AUTOMATIC FLIGHT CONTROL SYSTEM

The automatic flight control system includes stability augmentation, autopilot, and air data systems, plus additional subsystems furnishing attitude and navigational course inputs for the autopilot. The air data sys-

tem furnishes signals to the autopilot and inertial navigation systems. The stability augmentation system supplies signals to the hydraulic servos that operate the control surfaces. The inertial navigation system supplies attitude and navigational course inputs for the autopilot. Heading and attitude reference signals for the autopilot are also supplied by the Flight Reference System. The autopilot moves the aircraft hydraulic servos through the SAS. For further information on the autopilot and inertial navigation systems, refer to Section IV.

STABILITY AUGMENTATION SYSTEM

The three axis stability augmentation system is a combination of electronic and hydraulic equipment which augments the natural stability of the aircraft. It is designed for optimum performance at the basic mission cruise speed and altitude, but also provides improved stability for in-flight refueling, landing and takeoff. The SAS is part of the aircraft's basic control system and is normally used for all flight conditions.

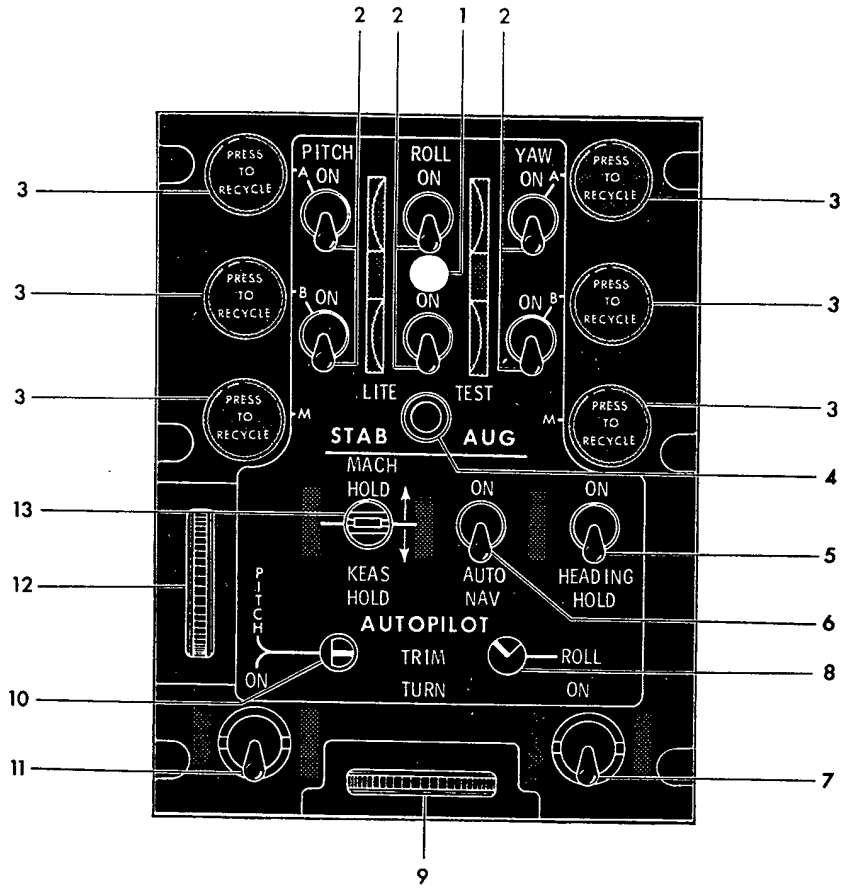
Dual electronic channels are provided for all axes and a third monitor channel is provided for both the pitch and yaw axis. Logic circuits compare the functioning of each pitch and yaw channel and automatically delete a failed channel. The pilot is also provided with a visual warning of a failed channel.

In the roll axis, each channel controls the elevons on only one side of the aircraft. The pilot may select a single channel if desired. Reliability is provided through dual hydraulic and inverter supplies. Each active channel in each axis is powered by separate supplies so that the two halves of each system are operated independently. A separate gyro system is provided for each channel in each axis. The design is such that no single failure except overheating of a complete gyro package can cause loss of all channels in one axis. Even if this occurred, it is unlikely that all of the gyros in the package would fail simultaneously. The SAS system compares the 3 electronic systems and disengages a malfunctioning A, B or M channel. Automatic gain increase is applied to the remaining channels so that control response remains the same. A malfunctioning electronics channel is indicated by illumination of the A or B and/or M light.

STABILITY AUGMENTATION PITCH AXIS

The pitch axis SAS consists of two independent active channels A and B and a third monitor M channel. The two independent active channels A and B provide the desired control through two pairs of tandem servos. There is one pair of servos on each side of the aircraft. The servos are in series with the autopilot and the pilot's control movements. Damping signals to the elevons do not move the control stick. Each A and B channel drives one servo on the left side of the aircraft and one on the right side. A channel uses A hydraulic system and B channel uses the B hydraulic system. This avoids loss of both channels in case of failure of either the A or B hydraulic systems. The sensors for the pitch axix are rate gyros located in tank No. 3. The gyros provide signals in proportion to the rate of pitch attitude change of the aircraft. Above 50,000 feet a "lagged" pitch rate gain is programmed into the pitch SAS electronic circuits. This pitch rate signal changeover may be felt as an abrupt pitch transient during a turn while climbing or descending through the 50,000 foot level. Refer to Section VII, Pitch Axis Characteristics due to Lagged Pitch Rate Switching. Phasing of the gyro signals is such that an angular pitch motion produces elevon movement to oppose and restrict attitude change. The system will take corrective action rapidly in the event of a gust disturbance. Pilot inputs are also opposed; however, the elevon motion produced by the SAS is designed to aid the pilot in avoiding overcontrol and improve the handling qualities of the aircraft.

SAS AND AUTO PILOT CONTROL PANEL



TYPE "A" PANEL

1 ROLL CHANNEL DISENGAGE LIGHT

2 SAS CHANNEL SWITCHES

3 SAS RECYCLE INDICATOR LIGHTS

4 SAS LIGHT TEST SWITCH

5 A/P HEADING HOLD SWITCH

6 A/P AUTO NAV SWITCH

7 A/P ROLL ENGAGE SWITCH

8 A/P ROLL TRIM SYNCRONIZATION INDICATOR

9 A/P TURN CONTROL WHEEL

10 A/P PITCH TRIM SYNCRONIZATION INDICATOR

11 A/P PITCH ENGAGE SWITCH

12 A/P PITCH CONTROL WHEEL

13 A/P MACH/KEAS HOLD SWITCH

F200-25(c)

Figure 1-25

The logic circuit is able to isolate a SAS failure in either the electronics or the servos. When a malfunction is isolated, the failed active channel will disengage and the system continues in operation on a single channel. Malfunctioning and disengageing of channels is indicated by indicator lights. The pitch axis can command a maximum elevon surface travel of 2.5° up to 6.5° down. Dual or single channel operation produces the same corrective action of the elevon surface. Power for A channel is from the A phase of No. 1 inverter bus. Power for B channel is from the A phase of No. 2 inverter. Monitor channel power is from the B phase of the No. 3 inverter. Each power source is protected by individual circuit breakers in the cockpit.

STABILITY AUGMENTATION YAW AXIS

The yaw axis of the SAS is very similar to the pitch axis, using two independent A and B channels and a monitor channel. There is one pair of hydraulic servos for each rudder, each pair mounted in a whiffletree arrangement. Damping signals to the rudder do not move the rudder pedals. Each A and B channel drives one servo on each side of the aircraft. The A hydraulic system is connected to A channel and the B hydraulic system to B channel. The rate gyro sensors for the three channels are identical to the pitch rate gyros, except for the physical orientation to sense yawing motions. A "Hi Pass" filter circuit is installed to allow passage of normal short term damping signals, but will stop the signals when a deliberate turn is made. A lateral accelerometer sensor is also used in each channel of the yaw axis. This sensor provides an input for high gain lateral acceleration function to provide a more rapid rudder response during engine failure conditions. However, this function will oppose the pilot when he is purposely trying to sideslip.

The logic circuit is identical to the pitch axis and functions in the same manner. The yaw axis can produce a maximum rudder travel of 8° left to 8° right. Corrective surface motion is the same regardless of one or two channel operation due to automatic gain doubling if only one channel is operative. Power for A channel is from the B phase of the No. 1 inverter, B channel from the B phase of the No. 2 inverter and the monitor channel from the B phase of the No. 3 inverter. The circuitry from each power source is protected by individual circuit breakers.

STABILITY AUGMENTATION ROLL AXIS

Roll axis reliability requirements are not as severe as pitch and yaw; therefore, less complicated circuitry and components are used. The roll axis has two independent channels, each operating the elevons on one side of the aircraft. A channel positions the left elevon surfaces and operates from the A hydraulic system. B channel positions the right elevon surfaces and operates from the B hydraulic system. There is no monitor channel. Each channel can be operated individually. Although the system gain is the same as two channel operation, roll control is not symmetrical. Coupling into the yaw and pitch axes is possible, but the systems operating in those axes minimize undesirable aircraft motion. Maximum elevon travel in the roll axis is 2° up to 2° down (each side), for a total of 4° differential with both systems operating. Power for A channel is from C phase of the No. 1 inverter and B channel from C phase of the No. 2 inverter.

STABILITY AUGMENTATION SYSTEM (SAS) CONTROL PANEL

The SAS control panel on the right console contains six channel switches, for A and B channels of the pitch, roll and yaw axis. The panel also contains a press-to-test switch and six indicator lights for the A, B and MON channels in the pitch and yaw axis. Three guarded switches for the backup pitch damper, pitch logic override and yaw logic override are located on the right side of the annunciator panel. A roll channel disengage light is located between the roll channel switches. Individual circuit breakers are located on both right and left consoles.

Channel Switches

There are six toggle switches located on the SAS control panel. There is one pair for each axis; pitch, roll and yaw. The forward switch of each pair is A channel and the rear switch is B channel. The switches have two positions; ON (forward) and OFF (aft). When electrical power is on the aircraft and the channel switches are OFF, the SAS electronics are powered, but the channel servos are not engaged into the control system. Moving the switches to the ON position engages the SAS servos providing the recycle light is extinguished. If the recycle light is not extinguished it must be depressed for engagement.

Recycle Indicator Lights

Six indicator lights are located on the SAS control panel adjacent to the pitch and yaw channel engage switches. One light is provided for each A, B and MON channel in the pitch and yaw axes. When the channel switch is on and the light is not illuminated, the channel is functioning properly. If the light is illuminated, it indicates that the channel has disengaged and the light may be pressed to recycle the channel. In the event the failure was momentary, this will reengage the channel. If the light reilluminates, the channel is malfunctioning, but it is not necessary to turn the channel engage switch off because the light indicates that automatic disengagement has occurred.

NOTE

The lighted recycle indicator light should be pressed down firmly and released. A control surface transient will occur if a hardover servo exists in that channel. Refer to Section III.

The six recycle lights will be illuminated when electrical power is applied to the aircraft. The channel switches must be on and the recycle lights must be pressed to engage the channel electronics to the servos. When engaged and operating, the channel lights will be out.

Roll Channel Disengage Light

A single roll channel disengage light is located between the two roll channel switches. When illuminated it indicates that both roll channels have disengaged. Disengagement results when the roll servo channel outputs differ by more than an amount equivalent to 0.6^{o} surface deflection. When operating on a single roll channel the light will not be illuminated and disengagement in the event of a failure is not provided. The switch must be ON for the active channel and OFF for the malfunctioning channel.

Light Test Switch

A pushbutton light test switch is located in the center of the SAS control panel. Pressing the button illuminates all SAS lights for test.

Backup Pitch Damper Switch

A guarded BUPD switch is located on the right side of the annunciator panel. It is guarded in the OFF position. It is used in case the SAS pitch channels are unusable due to electronic malfunctions or overheating of the pitch gyro package. In the ON position the backup gyro, located in the electronic compartment, supplies pitch rate signals through an independent electronic channel to either the A or B servos. The pitch logic override switch must be used to select their A or B servo operation.

NOTE

The primary purpose of the BUPD is to provide an emergency system for pitch stability augmentation during refueling and landing approach. The system is optimized for use at light weight, aft center of gravity and subsonic speeds. It is not intended as an emergency backup system during cruise. Refer to Section III, Emergency Procedures.

SAS Pitch Logic Override Switch

A guarded, three-position SAS pitch logic switch is located on the right side of the annunciator panel. It is OFF in the center guarded position and the logic circuit is operative. Placing the switch in the A (up) position deletes the logic circuit and selects A channel operation. In the B (down) position, the logic circuit is deleted and B channel is selected. The switch must be placed in either the A or B position when the BUPD is used. This selects operation of either the A or B servos.

NOTE

The override switch is only used as an emergency procedure. Refer to Section III.

SAS Yaw Logic Override Switch

A guarded, three-position SAS yaw logic switch is located on the right side of the annunciator panel below the pitch logic override switch. It is guarded in the OFF position. The A (up) position deletes the logic circuit and selects A channel operation. The B (down) position deletes the logic circuit and selects B channel operation.

NOTE

The override switch is only used as an emergency procedure. Refer to Section III.

PITOT-STATIC SYSTEMS

The pitot-static system supplies the total and static pressure necessary to operate the basic flight instruments and air data system components. The pressures are sensed by an electrically heated probe mounted on the nose of the aircraft. The probe and forward nose also serves as an antenna for the high frequency radio. The pitot orifice of the probe is divided inside the head to provide two separate pressure sources. It also has two circumferential sets of four static pressure ports each. One pitot and the aft set of static ports supply pressure signals to the air data computer and inlet air control systems. The other set of pickups supply pitot and static pressure directly to the speed sensors on the ejection seats, the altimeter, the rate of climb and airspeed indicators. An offset head on the left side of the probe provides yaw and pitch pressure signals to the inlet spike controls and to the stall warning light sensor.

The heating elements of the probe are controlled by the pitot heat switch located on the left side of the annunciator panel. Power is furnished by the left ac generator bus.

An alternate heated pitot static source is available from the Flight Recorder System. Refer to Flight Recorder, Section IV.

PITOT STATIC SYSTEM

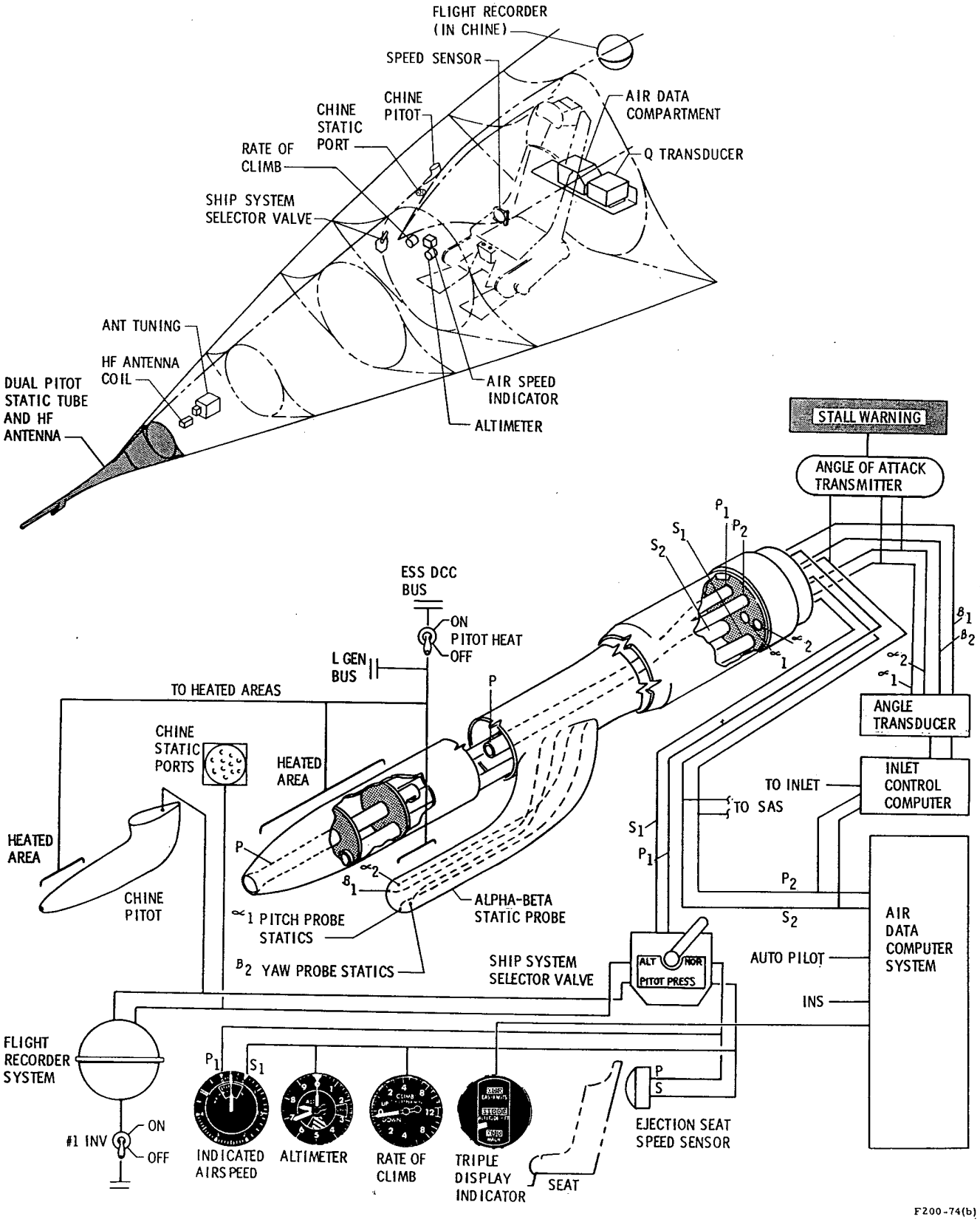


Figure 1-26

Pitot-Heat Switch and Indicator Light

A two-position toggle switch is located on the left side of the annunciator panel. In the ON (up) position ac power is applied to the heating elements of the pitot-static probe. The probe is grounded to the airframe in a manner which permits the HF radio to be operated while pitot heat is on. In the OFF (down) position ac power is disconnected from the probe heating elements.

The circuitry also incorporates an altitude switch and a PITOT HEAT light located on the annunciator panel. The pitot heat light will be on when the switch is in the ON position and the altitude is above 65,000 feet, and also when the switch is in the OFF position and the altitude is below 50,000 feet. The light will be OFF if when below 50,000 feet and pitot heat is ON, and when above 65,000 feet with the switch in the OFF position.

AIR DATA COMPUTER

The air data computer performs two functions, computation and display. The total and static pressures from the pitot-static probe are converted to electrical signals required for the pilot's triple display indicator, compressor inlet pressure indicator system, the automatic flight control and inertial navigation systems. The ports which supply pressure to the air data computer are separate from those that furnish pressure to the basic flight instruments. Therefore, failure of the air data computer pressure source will not leave the pilot without the altitude, vertical velocity or airspeed information. The air data computer converts pitot-static pressures into proportional rotary shaft positions which are equivalent to pressure altitude and dynamic pressure. These shaft positions are combined in a mechanical analog computer made up of cams, gears and differentials to drive the output functions. Outputs of the air data computer and the using equipment are listed below:

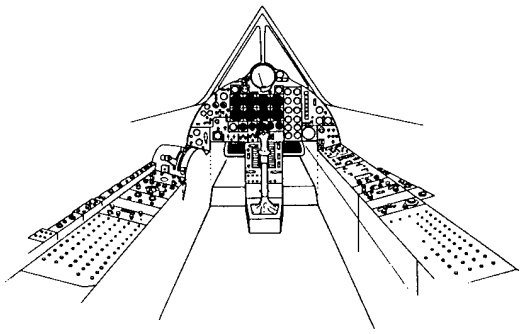
OUTPUT SIGNALS	USING EQUIPMENT
Pressure Altitude Equivalent Airspeed Mach	Triple Display Indicator
KEAS + MACH	Compressor Inlet Pressure Indicator
KEAS Mach Mach Rate Altitude Dynamic Pressure	Autopilot
Pressure Altitude	Inertial Navigator Computer

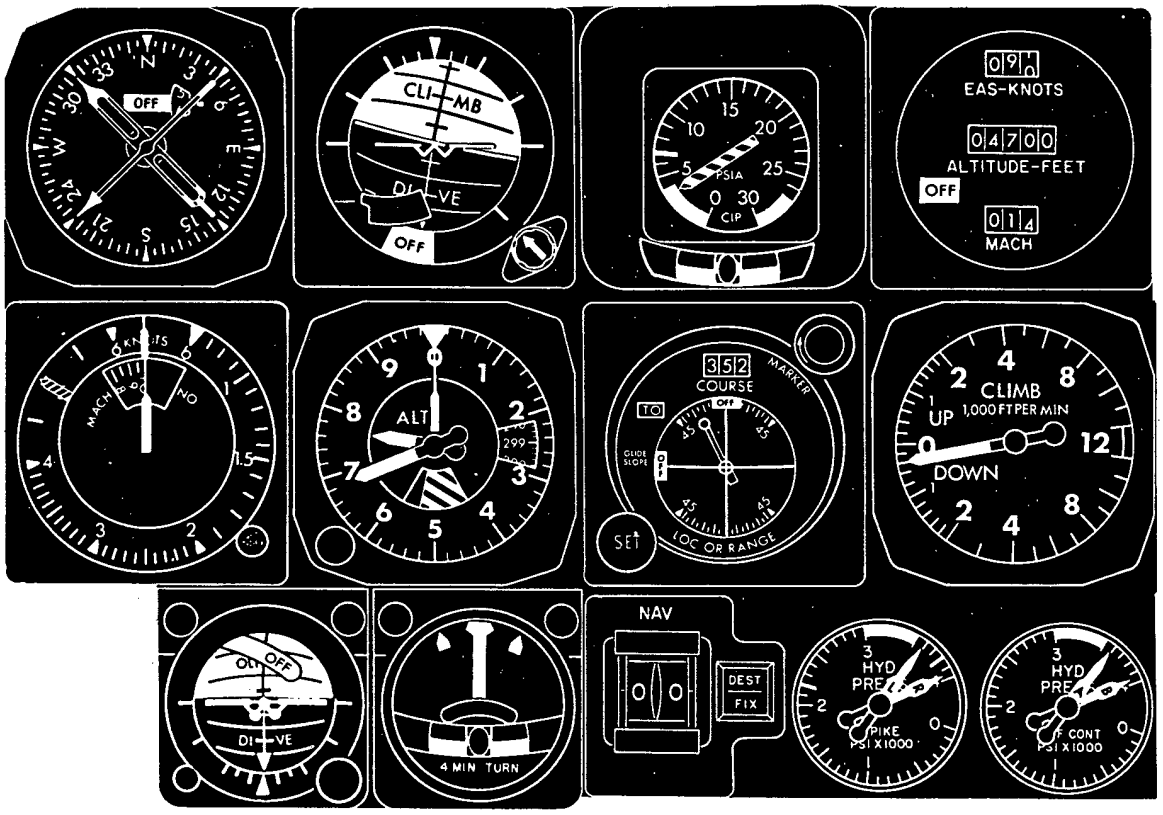
Power for the air data computer is furnished either by the No. 1 or No. 3 inverter depending on the position of the autopilot selector switch.

Triple Display Indicators

A triple display indicator is located on the instrument panel to provide digital displays of airspeed, altitude, and Mach number as computed by the Air Data Computer. The altitude indication range of the TDI is from

FLIGHT INSTRUMENTS





F200-70(d)

Figure 1-27

0 to 99,950 feet. At 100,000 feet the first digit is dropped, indicating 09,950 feet at 109,950 feet pressure altitude, the maximum limit of the ADC signal to the instrument. The Mach number display capability range of each instrument is 0 to 3.99; however, the minimum indication at static conditions normally ranges from 0.1 to 0.2 Mach number and the maximum indication would be Mach 3.5 for a normally functioning instrument. This range corresponds to the range of signals which the ADC is capable of providing. The TDI displays airspeed in knots equivalent airspeed (KEAS) within an instrument capability from 0 to 599 KEAS; however, the minimum indication is normally 75 to 110 KEAS to correspond with the minimum ADC signal provided. The maximum signal provided by the ADC results in an airspeed indication which decreases from 599 KEAS at sea level to 523 KEAS at 66,800 feet and Mach 3.5, and then decreases further at high altitudes to show the KEAS corresponding to Mach 3.5 and the existing pressure altitude. An off flag appears on the face of the instrument if the ADC loses power. Power for the instrument is from the No. 1 or No. 3 inverter.

NOTE

- Indications of the triple display indicator and the basic pitot-static flight instruments should be periodically cross checked to confirm proper system operation. Refer to figure A1-2, Appendix I.

- The triple display indicator is primarily used for aircraft control above FL 180 and to maintain proper airspeed control during climbs to FL 180. Basic pitot-static operated flight instruments shall be used in the landing pattern, during takeoff until proper climb schedule is established on the TDI, and during all simulated or actual instrument flight below FL 180.

- If KEAS indications oscillate between two values on the high end of the range, it is an indication that the indicator limit is being approached.

INSTRUMENTS

For information regarding instruments that are an integral part of a particular system, refer to applicable paragraphs in this section and Section IV.

Airspeed-Mach Meter

A combination airspeed and Mach meter operating directly from pitot-static pressure is located in the flight instrument group. This is a special instrument with airspeed and Mach number ranges compatible with aircraft performance capabilities. Mach number and indicated airspeed are read simultaneously on the window and outer index respectively. A limit airspeed needle (white barred) shows the airspeed limit of the aircraft. The actual airspeed limit is in equivalent airspeed; however, the needle varies with altitude to read the indicated airspeed that converts to equivalent airspeed.

Altimeter

A sensitive pressure altimeter is located on the instrument panel. In addition to the 1000 foot and 100 foot pointers, it also has a 10,000 foot pointer. This pointer extends to the edge of the dial with a triangular marker at its extremity. The center disc has a cutout through which yellow and black warning stripes appear at altitudes below 16,000 feet. The barometric pressure scale is in a cutout at the right side and is set by a knob located at the lower left side of the instrument.

Attitude Indicator (MM-3)

The attitude indicator is located in the basic flight instrument group on the instrument panel. It provides constant visual indication of nose and wing position in relation to the earth's surface. Attitude indications are presented by a spherical graduated dial, a W reference line, a bank pointer, and a marked outer ring. A horizontal line is formed on the spherical dial by the meeting of a gray, upper climb section and a black lower dive section. The instrument shows attitude in climb or dive up to 85 degrees.

NOTE

At approximately 85 degrees climb or dive, the attitude indicator will flip but will not tumble. The 180 degree flip in roll will be very rapid and the instrument will accurately indicate pitch and roll attitudes immediately thereafter. Some small inaccuracies may develop after a series of maneuvers beyond the 85 degree climb or dive attitude. These inaccuracies will automatically be cancelled out at the erection rate of .8° to 1.8° per minute.

The W reference line remains fixed with the marked outer ring and represents the aircraft in miniature. The spherical dial moves up or down, or the whole spherical dial assembly rotates within the instrument case behind the W reference line and outer ring to indicate aircraft attitudes. As the dial assembly rotates, the bank pointer moves with it to indicate degrees of bank on the outer ring. The outer ring indicates 0° - 90° bank. The spherical dial and pointer are capable of rotating a full 360 degrees of roll with the aircraft. Pitch attitude of the aircraft is indicated by the position of the horizon line in relation to the miniature aircraft. A pitch adjustment knob on the lower right side is used to change the position of the spherical dial as desired. During initial gyro erection, and when power is off or is insufficient to keep the gyro stabilized, a warning OFF flag appears at the bottom of the indicator. The autopilot and attitude reference selector switch is used to select pitch and roll attitude signals from either the INS or FRS stable platforms.

CAUTION

To avoid gross pitch attitude errors the pitch adjustment knob of the attitude indicator should be adjusted to align the index marks before the autopilot and attitude reference selector switch is changed in flight.

NOTE

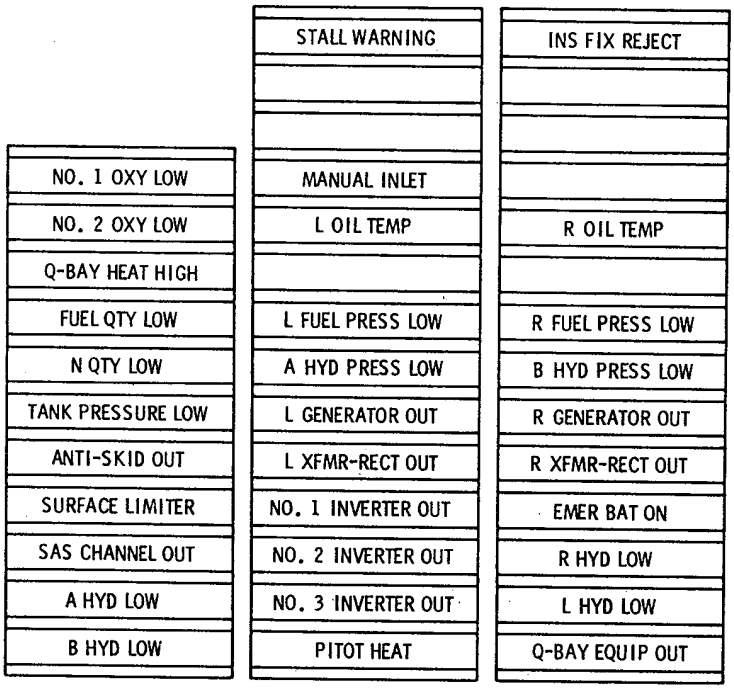
To determine a possible malfunction of the attitude indicator, an occasional accuracy check should be made by comparing it against the standby attitude indicator and other basic flight instruments.

The system is powered by the No. 1 and No. 3 inverter depending on the position of the autopilot selector switch.

Standby Attitude Indicator

The standby attitude indicator located on the lower left side of the instrument panel provides the pilot with an independent attitude reference. It contains a sphere inscribed with an artificial horizon and calibrated in degrees of aircraft angle of pitch. The globe is detailed to represent the sky and earth areas, and is capable of rotating to indicate pitch angles of ± 82 degrees and roll angles of 360 degrees. The bank angle scale is marked on the lower periphery. A pitch reference adjustment knob is provided on the lower right corner of the instrument for positioning the reference bar as desired. A fast erect pushbutton is provided on a small panel above the throttles.

ANNUNCIATOR PANELS



F200-69(c)

Figure 1-28

CAUTION

Do not hold fast erect button for more than 45 seconds to prevent overheating of fast erect motor.

This instrument has its own self-contained gyro and is not dependent on another reference source. The OFF flag will be visible whenever power to the indicator is interrupted. Power is provided by the C phase of the No. 2 inverter.

Vertical Velocity Indicator

A vertical velocity indicator is located on the instrument panel and shows the rate of change of altitude in feet per minute. Changes in pressure due to changes in altitude are sensed by the static system and transmitted to the indicator. Depending on the instrument installed the instrument is capable of indicating vertical speed of 0 to ± 12,000 feet per minute or 0 to 6,000 feet per minute. An over-pressure diaphragm and valve prevent excessive rates of climb or descent from damaging the instrument.

Turn and Slip Indicator

A turn and slip indicator is installed on the instrument panel. The indicator is calibrated for either a two or four minute turn. The indicator is powered by the essential dc bus. An additional larger slip indicator is mounted on the upper center instrument panel beneath the CIP indicator.

LANDING GEAR SYSTEM

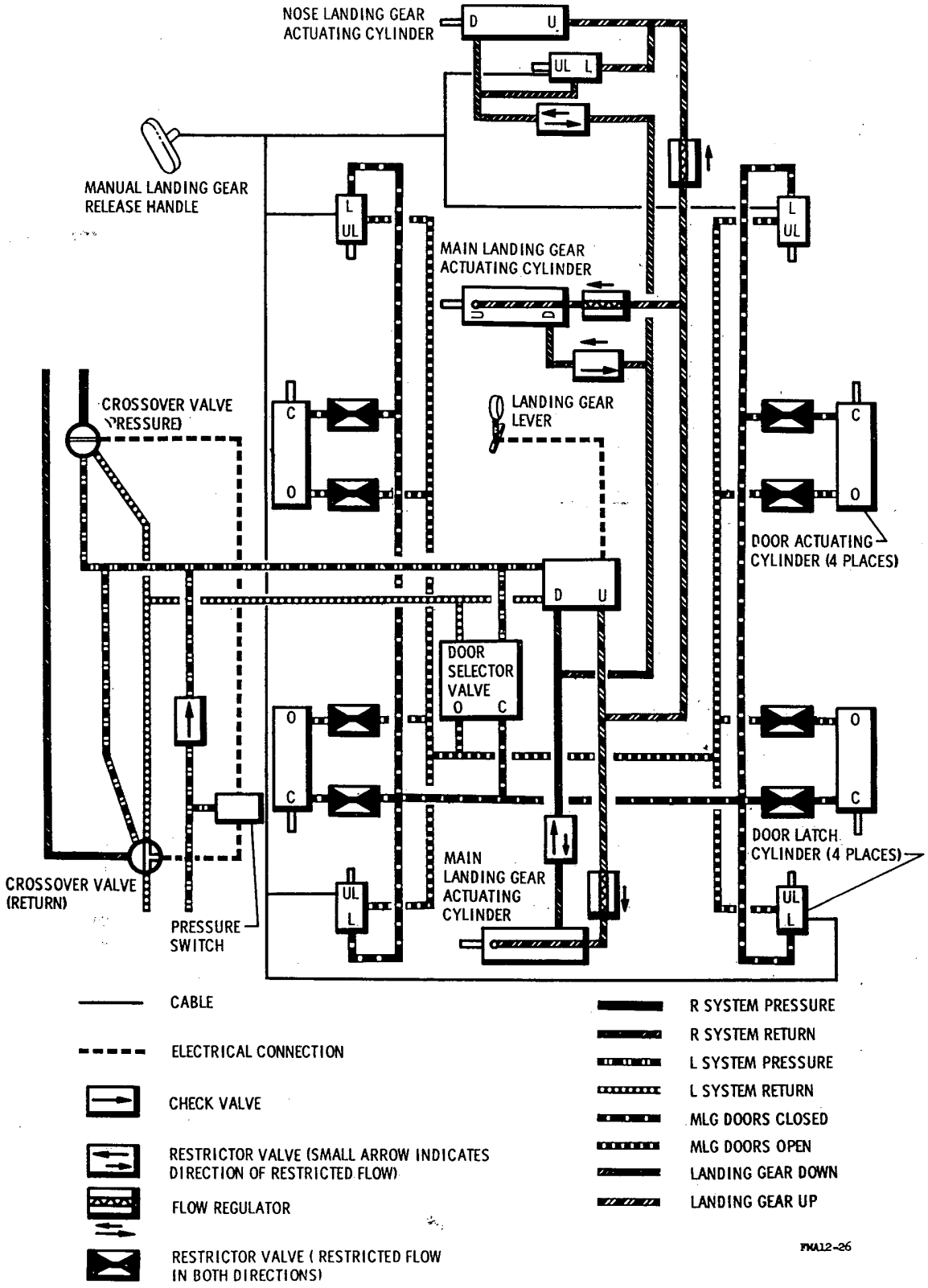


Figure 1-29

Clocks

An elapsed time clock is located on the instrument panel. It contains an elapsed time mechanism that is started and stopped by pushing the winding knob. An A13A clock is also installed in the panel. The second hand is started and stopped by the small button on the upper right corner. The third hand serves as a 60 minute recorder.

EMERGENCY EQUIPMENT

MASTER WARNING SYSTEM

An annunciator panel is mounted on the lower instrument panel. The panel contains individual warning lights that indicate malfunctions or failures of equipment and systems. Illumination of any individual light also illuminates an amber master caution light on the upper portion of the instrument panel. Once illuminated, the master caution light can be extinguished (reset) by depressing the light. The individual annunciator panel light will remain illuminated. Another malfunction again illuminates the master caution light. Warning lights are automatically dimmed when the instrument panel lights are on. The master warning system does not include the fire warning and landing gear unsafe lights. Power is furnished by the essential dc bus.

NACELLE FIRE WARNING SYSTEM

A fire warning system detects and indicates the presence of a fire in the engine nacelles. A hot spot anywhere along the length of the detection circuit will illuminate the light of that particular nacelle. The lights are located on the pilot's instrument panel above the respective column of instruments pertaining to each engine.

Nacelle Fire Warning Lights

Left and right nacelle FIRE warning lights located on the top right side of the instrument panel, illuminate when nacelle temperature at the turbine or at the afterburner exceeds $1050^{\circ}F \pm 50^{\circ}$. Flip down glare shields are provided for night flying. Power for the circuit is furnished by the No. 1 inverter.

STALL WARNING LIGHT

A STALL WARNING light is located on the annunciator panel which is illuminated when the aircraft angle of attack reaches $\pm$ 14 degrees and the nose landing gear scissor switch is open. Pressure differences between the α 1 and 2 inlets on the pitch and yaw probe are sensed by a pitch transmitter unit to actuate this light. A steady tone warning signal is also produced in the pilot's earphone. Power for the stall warning light is furnished by the essential dc bus.

LANDING GEAR SYSTEM

The tricycle landing gear and the main wheel well inboard doors are electrically controlled and hydraulically actuated. The main gear outboard doors and the nose gear doors are linked directly to the respective gear struts. Each three wheeled main gear retracts inboard into the fuselage and the dual wheel nose gear retracts forward into the fuselage. The main gear is locked up by the inboard doors and the nose gear by an uplock which engages the strut. There is no hydraulic pressure on the gear when it is up and locked. Down locks inside the actuating cylinders hold the gear in place in the extended position. Hydraulic pressure is also on the gear in the extended position when L system pressure is available. The landing gear cylinders and doors are actuated in the proper order by two sequencing valves. Normal gear operation is

powered by the L hydraulic pump on the left engine. Should pressure drop to 2000-2200 psi during retraction, the power source automatically becomes the R hydraulic pump. R hydraulic pressure will not extend the gear in the event of an L system failure and the manual landing gear release must be used. Normal gear extension time is 12-16 seconds.

LANDING GEAR LEVER

A wheel shaped landing gear lever is installed on the lower left side of the instrument panel just forward of the throttle quadrant. The lever has two positions; UP and DOWN. A locking mechanism is provided to prevent the gear lever from being inadvertently placed in the DOWN position. A button which extends upward from the top of the lever must be pressed forward in order to release the lock mechanism. An override button is installed just above the gear lever and may be used to override the ground safety switch should it become necessary to raise the gear when the weight of the aircraft is on the landing gear. Once energized, the gear lever must be recycled to the DOWN position in order to bring the ground safety switch back into the circuit. A red light installed in the transparent wheel illuminates during cycling, or when the gear is in an unsafe condition. Power for the circuit is furnished by the essential dc bus.

Manual Landing Gear Release Handle

A manual landing gear release handle labeled GEAR RELEASE is installed on the annunciator panel. If the L hydraulic system has failed but R hydraulic pressure is available, the landing gear lever must be in the DOWN position or the landing gear CONT circuit breaker must be pulled out before pulling the GEAR RELEASE handle. Otherwise, the R system will retract the gear. The gear extends by gravity force. Approximately 9 inches of pull on the handle is required since the uplocks are released at different positions along the cable length. The nose gear uplock is released first followed by the right gear then the left. Gear retraction is possible after being lowered by the manual gear release handle, provided L or R hydraulic system pressure is available.

Gear and Warning Light Test Button

A gear and warning light pushbutton switch is located on the left forward panel. When depressed it illuminates the landing gear lever red light, all annunciator panel lights, the right and left nacelle fire warning lights, and actuates the gear warning tone in the headset. It is also used to test the three green landing gear position lights when airborne.

Landing Gear Position Lights

Three green lights, located on the left side of the instrument panel indicate the down and locked condition of the landing gear. The location of each light corresponds to the respective wheel it monitors. Power is from the essential dc bus.

Landing Gear Warning Light and Audible Warning

The red landing gear warning light in the landing gear lever handle when illuminated indicates:

1. Gear is cycling.
2. Gear system is not locked in the UP or DOWN position.
3. Gear is UP and throttle settings are below MILITARY and altitude is below 10,000 feet.

A pulsed tone warning signal is also produced in the pilot's earphones when the throttles are retarded below approximately 1/3 the distance between the IDLE and MIL throttle settings, the landing gear is not in the down and locked position and aircraft altitude is below 10,000 feet ± 500 feet. Power for the light and pulsed tone warning is furnished by the essential dc bus.

Landing Gear Warning Cutout Button

The audio gear warning signal can be eliminated by pressing the GR SIG REL push-button switch on the instrument panel. The circuit is reactivated when the throttles are advanced above the minimum cruise setting. Power is supplied by the essential dc bus.

Land Gear Ground Safety Pins

Removable ground safety pins are installed in the landing gear assemblies to prevent inadvertent retraction of the gear while the aircraft is on the ground. Warning streamers direct attention to their removal before flight. An additional set of ground safety pins is provided in a container behind the seat.

LANDING GEAR STRUT DAMPER

A landing gear strut damper system is installed to control gear "walking" during brake operation. The system is sensitive to less than one g change in fore and aft acceleration. The damping is controlled through a g monitoring valve which automatically increases or decreases the brake pressure as required. Hydraulic pressure for the damper system is provided by the L system.

NOSEWHEEL STEERING SYSTEM

The nosewheel steering system provides power steering for directional control when the aircraft weight is on any one gear. The nosewheel is steerable 30 degrees either side of center. Steering is accomplished by a hydraulic steer-damper unit controlled through a cable system by the rudder pedals L hydraulic system pressure from the nose landing gear down line is routed to the steering system through a shutoff valve, which is controlled by the nosewheel steering (NWS) button on the control stick grip. Steering is engaged by depressing the NWS button and matching pedal position with nosewheel angle. A holding relay circuit allows the NWS button to be released after it is once depressed and steering will stay engaged. It is disengaged when the NWS button is again pressed and released. Steering is engaged at any time the NWS button is held depressed. Nosewheel steering radius is approximately 75 feet. A mechanically operated centering cam automatically centers the nosewheel when it retracts. Power for the system is furnished by the essential dc bus.

NOTE

Nosewheel steering is operable only if essential dc bus power is available and weight of the aircraft is on any one gear. If the L system pressure should drop below 2000-2200 psi alternate nosewheel steering may be obtained by placing the brake switch to ALT STEER & BRAKE position.

WARNING

The landing gear side load strength is critical. Side loads during takeoff, landing and ground operation must be kept to a minimum.

BRAKE SYSTEM

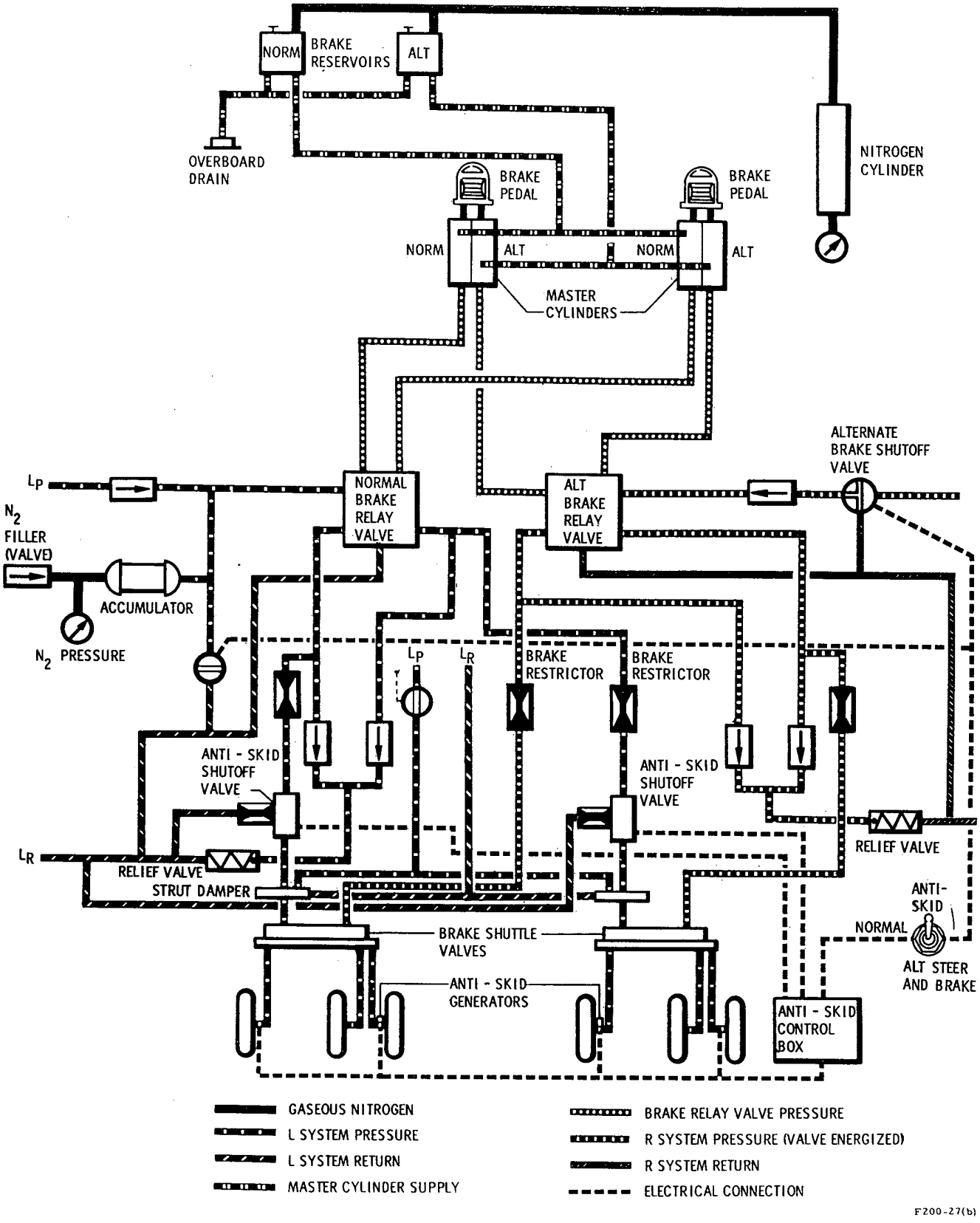


Figure 1-30

WHEEL BRAKE SYSTEM

The aircraft is equipped with artificial feel hydraulically operated power brakes. Depressing the rudder pedals actuates the four rotor brakes on each of the six main wheels. The L hydraulic system furnishes brake pressure with optional antiskid operation. The hydraulic pressure to the brakes is approximately 1200 psi. Should the L hydraulic system fail, alternate brakes are available. The alternate brakes operate from an independent system using R hydraulic pressure with no antiskid provision.

A small accumulator is incorporated in the normal brake system which should provide up to five brake applications after L and R hydraulic failure provided accumulator pressure has not been dumped by selecting alternate brakes. Certain types of hydraulic system failures such as a broken line could deplete the system fluid. Normal or antiskid brakes are usable if left hydraulic pressure is steady and above 2200 psi. Alternate brakes are used if left hydraulic system pressure is below this pressure.

Brake Switch

A three-position brake switch is located on the left side of the instrument panel. In the NORM (center) position, brake pressure from the L hydraulic system is available, but the antiskid system is not operative. In the ANTISKID (up) position, the antiskid system is operative. In the ALT STEER & BRAKE (down) position, the brakes, NWS and air refueling system are powered by the R hydraulic system if left system pressure is below 1250 psi. Power for the circuit is furnished by the essential dc bus.

WARNING

Do not switch to alternate brakes unless normal left hydraulic pressure is unavailable or normal brakes are inoperative. Pressure may be trapped in the brakes after the pedals are released, causing grabbing or locking.

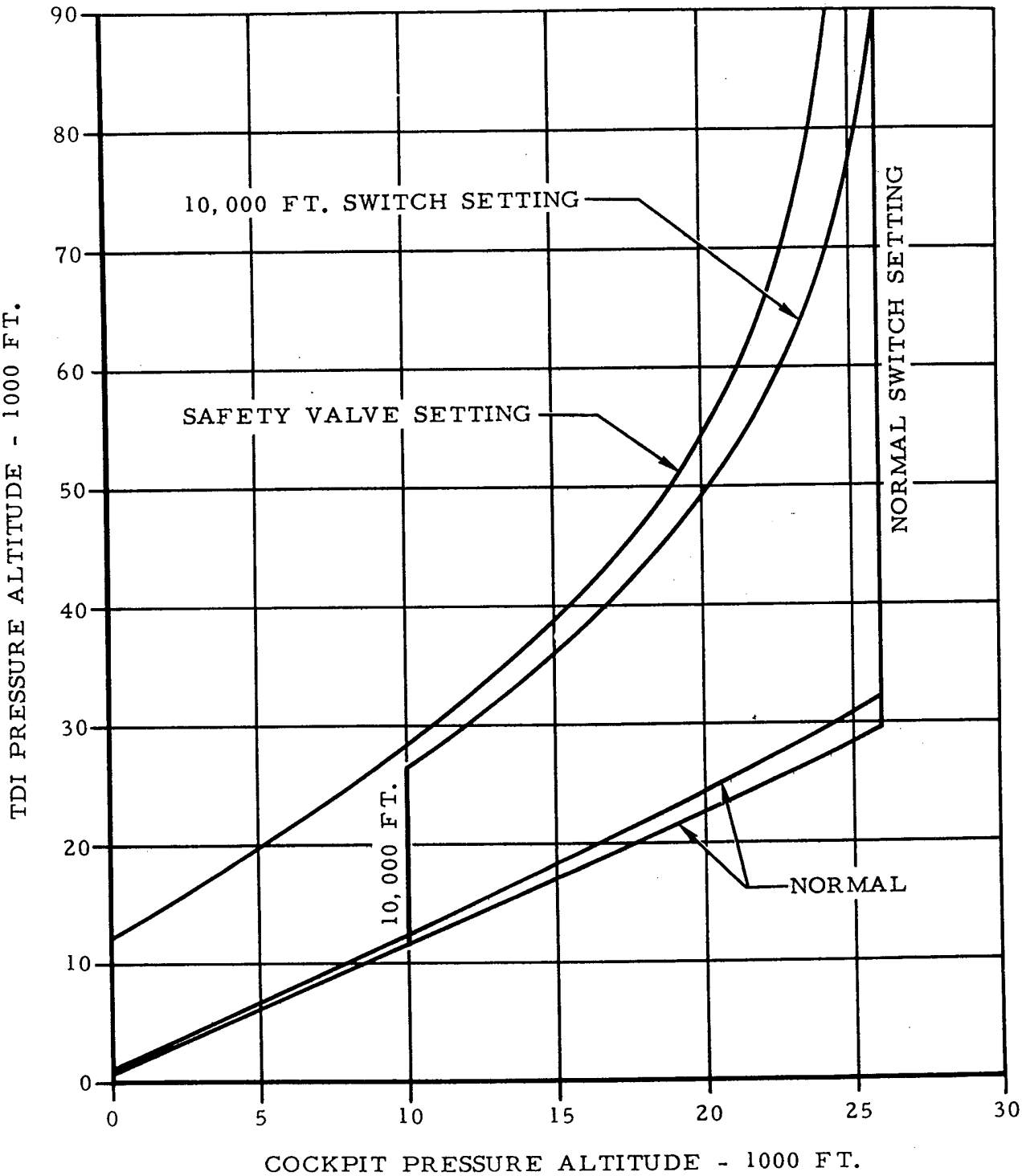
Anti-skid Out Indicator Light

Illumination of the ANTI-SKID OUT indicator light on the annunciator panel indicates that the anti-skid system is inoperative. When the aircraft is on the ground, the light will be illuminated when the brake switch is in the NORM or ALT STEER & BRAKE position. The light will be off when the switch is in the ANTI-SKID position, if the anti-skid control box and wheel generators are operative. If the fail safe circuit within the anti-skid control box is tripped and power from the essential dc bus is on the system, the light will illuminate. The light is off at all times when the weight of the aircraft is not on the gear.

DRAG CHUTE SYSTEM

The drag chute system is provided to reduce landing roll and aborted takeoff roll out distance. The 45-foot ribbon type parachute is packed in a deployment bag and stowed in the upper aft end of the fuselage. It rides free in the compartment and is locked onto the airplane at the initial stage of its deployment action. The neck of the drag chute link incorporates a breakaway section to protect against aircraft structural damage if the chute is deployed at too fast a speed. The chute deployment is actuated electrically and power is furnished by the essential dc bus.

COCKPIT PRESSURIZATION SCHEDULE



F200-97

Figure 1-31

Drag Chute Handle

The drag chute deploy and jettison handle is located on the left edge of the instrument glare shield. When pulled the handle activates micro switches which deploys the drag chute. When turned 90 degrees counterclockwise and pushed in, the drag chute is jettisoned. Power for the circuit is furnished by the essential dc bus.

AIR CONDITIONING AND PRESSURIZATION SYSTEM

Similar left and right hand air conditioning and pressurization systems utilize high pressure ninth stage compressor air from each engine to pressurize and cool the cockpit and equipment compartments. System shutoff valves allow compressor air to flow when the engines are running and the system switches are ON. Cooling is accomplished by ducting the bleed air through a ram air heat exchanger, primary and secondary fuel/air heat exchangers, and through an air cycle refrigerator. Temperature of the air supplied by each system is modulated by temperature control bypass valves located upstream from the air cycle refrigerators. The bypass valves are positioned by control switches located in the cockpit.

A water separator is installed in each air conditioning system downstream of the air-cycle refrigeration units. Below an altitude of approximately 36,000 feet a pressure switch in the automatic temperature control circuit limits the minimum outlet temperature of the air from the air-cycle refrigeration to 35°F to prevent freezing of water in the separator. Using the manual temperature controls will allow lower temperature air to come from the refrigerator but icing of the water separator may occur if humidity is high. Above 36,000 feet the altitude pressure switch opens the water separator bypass valve and air does not flow through the separator.

The left engine normally furnishes air for the cockpit, nose compartment, ventilated flying suit, inverters and INS platform. The right engine normally furnishes air to the E-bay where it mixes with cockpit discharge air for ventilation of the E-bay, Q-bay, and the aft equipment compartments. A fixed orifice restriction and a duct dividing into two outlets provide for a portion of the right system air to flow to the upper part of the cockpit. A crossover system is provided to supply right engine system air to the cockpit and equipment normally supplied by the left engine system. The operation of the crossover system will not depressurize the Q-bay since the cockpit air exhausts into the Q-bay; however, a rise in temperature will occur in the Q-bay. High pressure canopy and hatch seal air and windshield defog air is furnished from both right and left engine systems by ducts connected downstream from the primary fuel/air heat exchangers.

COCKPIT COOLING AND PRESSURIZATION

When the aircraft is at high altitude, the pressurization systems maintain a constant altitude of approximately 26,000 feet in the cockpit and nose and 28,000 feet in the Q-bay.

Cabin Pressure Schedule Switch

The cockpit pressure schedule switch is a two position toggle switch labeled CABIN PRESS located on the lower center of the instrument panel. In the NORMAL (down) position, the cockpit and Q-bay pressurization systems provide the normal pressure schedule and will maintain constant altitudes of 26,000 and 28,000 feet when the aircraft is above 32,000 feet. In the 10,000 feet (up) position, the cockpit pressure is regulated to a 5 psi maximum differential and will maintain a 10,000 foot cockpit altitude up to

AIR CONDITIONING AND PRESSURIZATION SYSTEM

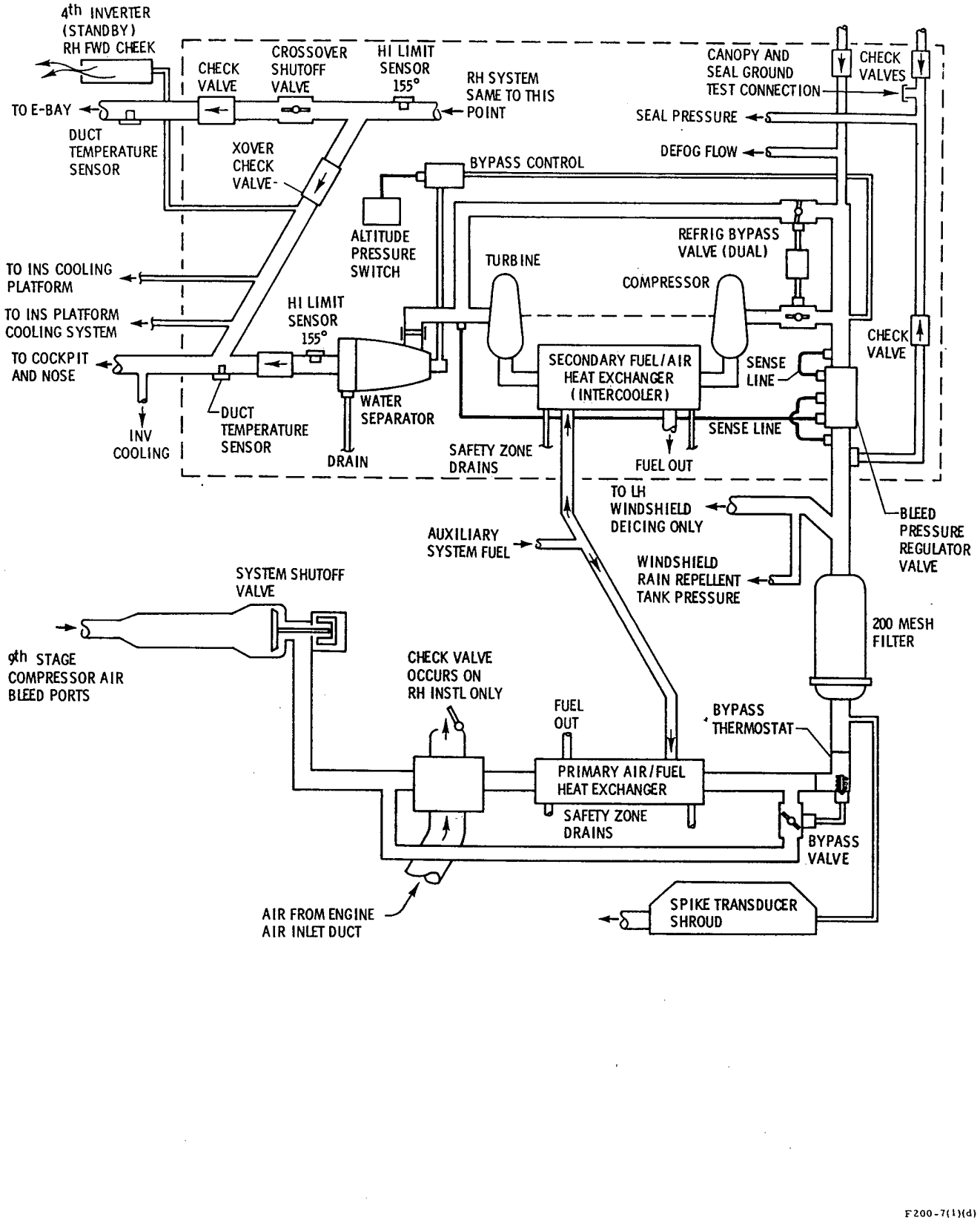
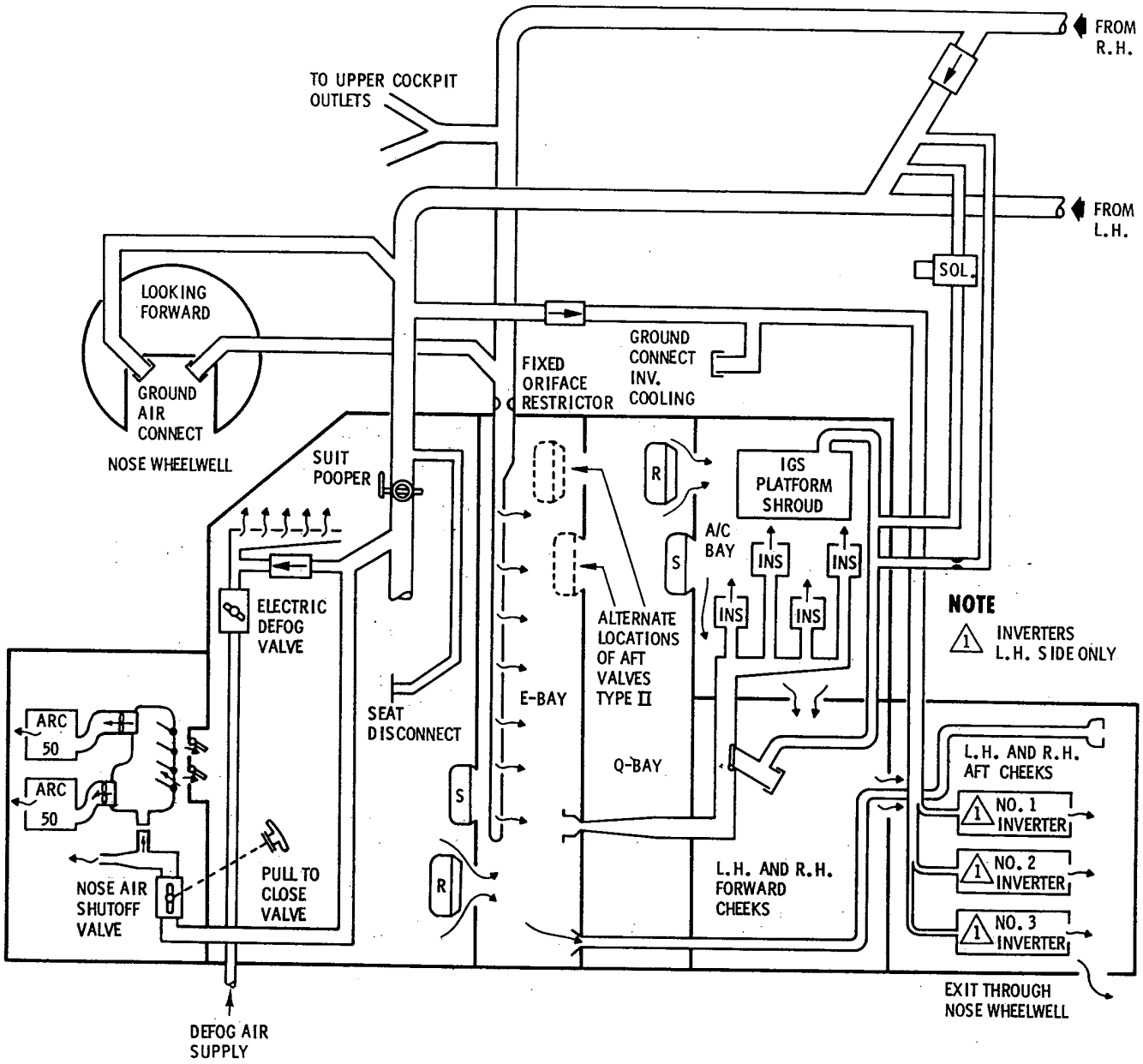


Figure 1-32 (Sheet 1 of 3)

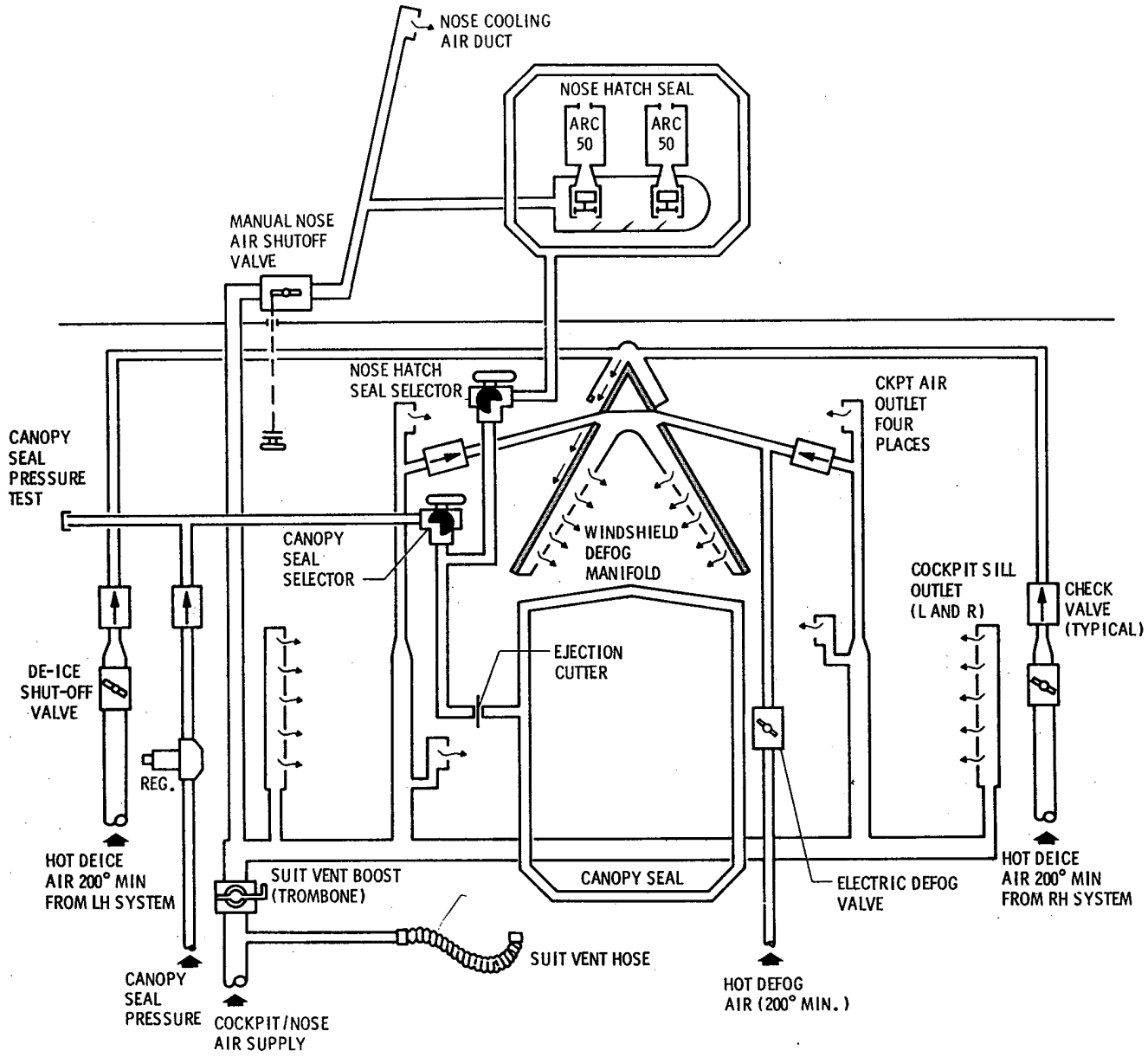
AIR CONDITIONING AND PRESSURIZATION SYSTEM



F200-7(2)(d)

Figure 1-32 (Sheet 2 of 3)

AIR CONDITIONING AND PRESSURIZATION SYSTEM



F200-7(3)(d)

Figure 1-32 (Sheet 3 of 3)

26,500 feet. The 10,000 foot position is intended for use during subsonic low altitude ferry flights but is not restricted for use as desired during climbs, descents and high altitude cruise. A rate control is incorporated which limits the pressure change to 2500 ft/min when changing schedules.

NOTE

During descents from high altitude, only the normal cockpit pressure schedule will provide optimum cockpit cooling. The 10,000 foot schedule will not cool the cockpit in descents as well as the normal schedule due to increased turbine back pressure.

Cockpit Air Switch

The cockpit air switch is a three position switch with labeled positions of NORM (left) OFF (center) and EMER (right). In the NORM position the left system shutoff valve is deenergized to open and the left engine system furnishes air to the cockpit. In the OFF position the left shutoff valve is energized to closed, shuting off the normal cockpit air. In the EMER position left system air is shutoff, the crossover valve in the right system is energized closed and the right system shutoff valve is deenergized to open and right system air is furnished to the cockpit. The circuit is powered by the essential dc bus.

NOTE

In the EMER position the Q-bay system switch OFF position is ineffective and right system air must be shut off by moving the cockpit air switch to the NORM position.

Q-Bay System Switch

The Q-bay system switch has two positions and is located on the upper left side of the instrument panel. In the ON (up) position the right engine system's shutoff valve is deenergized to open so that right engine air can flow to the E-bay. If the cockpit air switch is in the crossover or EMER position this air will be ducted to the cockpit and will enter the E-bay through the cockpit regulator valving. In the OFF position the shutoff valve is energized to off and Q-bay system air is shutoff if the cockpit air switch is in NORM position. The circuit is powered by the essential dc bus.

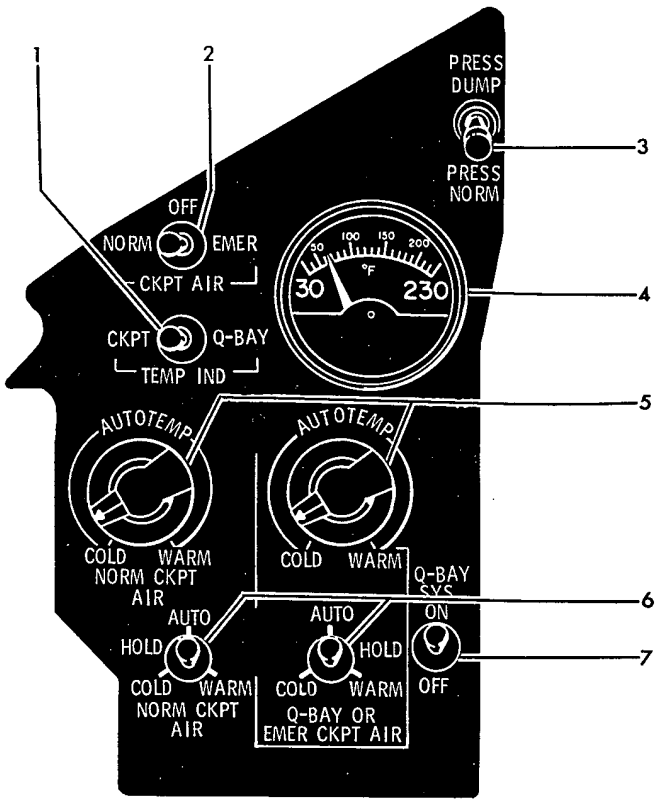
Temperature Control Selector Switches

Two selector switches, one for the cockpit and one for the Q-bay and/or emergency cockpit air, are installed on the upper left instrument panel. Each switch has four positions; AUTO (up), COLD (down left), WARM (down right) and HOLD (center). The switches are spring loaded to HOLD from the COLD and WARM positions. The switches will normally be in the AUTO position; however, the pilot can manually override the automatic feature by moving the switch to either the momentary COLD or WARM position. The manual COLD control will provide colder air, if required, than the automatic control. The No. 1 inverter powers the cockpit temperature control system. The No. 2 inverter powers the Q-bay and/or emergency cockpit air temperature control system.

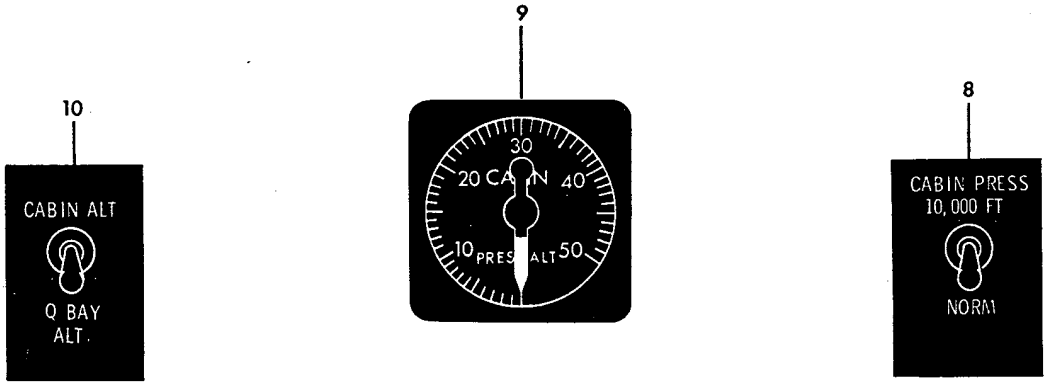
Temperature Indicator Selector Switch

A temperature indicator selector switch located on the upper left instrument panel allows the pilot to monitor cockpit or Q-bay temperature. Cockpit temperature is indicated when the switch is placed in the CKPT (left) position and Q-bay temperature when

AIR CONDITIONING CONTROL PANEL



1 COCKPIT TEMPERATURE MONITOR SELECTOR SWITCH
2 COCKPIT AIR SWITCH
3 DEPRESSURIZATION SWITCH (DUMP)
4 TEMPERATURE INDICATOR
5 TEMPERATURE CONTROL KNOBS
6 TEMPERATURE CONTROL SELECTOR SWITCHES
7 Q-BAY SYSTEM SWITCH
8 CABIN PRESSURE SCHEDULE SELECTOR SWITCH
9 CABIN ALTITUDE GAGE
10 ALTITUDE INDICATOR SELECTOR LEVER



F200-50(c)

Figure 1-33

the switch is placed in the Q-BAY (right) position. Power for the indicator is furnished by the essential dc bus.

NOTE

Up to a point, the insulation and ventilation of the pressure suit will keep the pilot comfortable in a cockpit environment that is too warm. The temperature indicator is provided so as to allow anticipation of a temperature condition that might eventually become too hot for comfort. If the cockpit temperature approaches 140°, the suit will not keep the pilot comfortable.

Temperature Control Rheostats

Two temperature control rheostats, one for the cockpit and one for the Q-bay and/or emergency cockpit air are installed on the upper left instrument panel. Arrows indicate the direction of rotation necessary to increase temperature. Generally, it is necessary to periodically rotate the respective temperature control rheostat toward the COLD position to maintain a comfortable temperature in the ventilated flying suit and keep the Q-bay temperature in tolerance. Electrical power for the cockpit temperature control circuits is from the No. 1 inverter. Q-bay and/or cockpit emergency air control is powered by the No. 2 inverter.

Pressure Altitude Gage

A cockpit and Q-bay pressure altitude gage is located on the left forward panel and indicates either cockpit or Q-bay altitude as selected by the cabin-Q-bay selector.

Altitude Selector Lever

This switch type lever is located on the left forward panel. It is labeled CABIN ALT in the up position and Q-BAY ALT in the down position and selects the respective pressure altitude to be indicated on the gage.

Depressurization (Dump) Switch

A two position lift-lock depressurization switch labeled PRESS DUMP and PRESS NORM is located on the upper left instrument panel. When the switch is pulled out and moved to the PRESS DUMP position, both the cockpit and Q-bay will be depressurized by the opening of the safety valves. When moved to the PRESS NORM position the safety valves will close and the cockpit and Q-bay will repressurize.

WARNING

Depressurization and repressurization will occur at an extremely rapid rate.

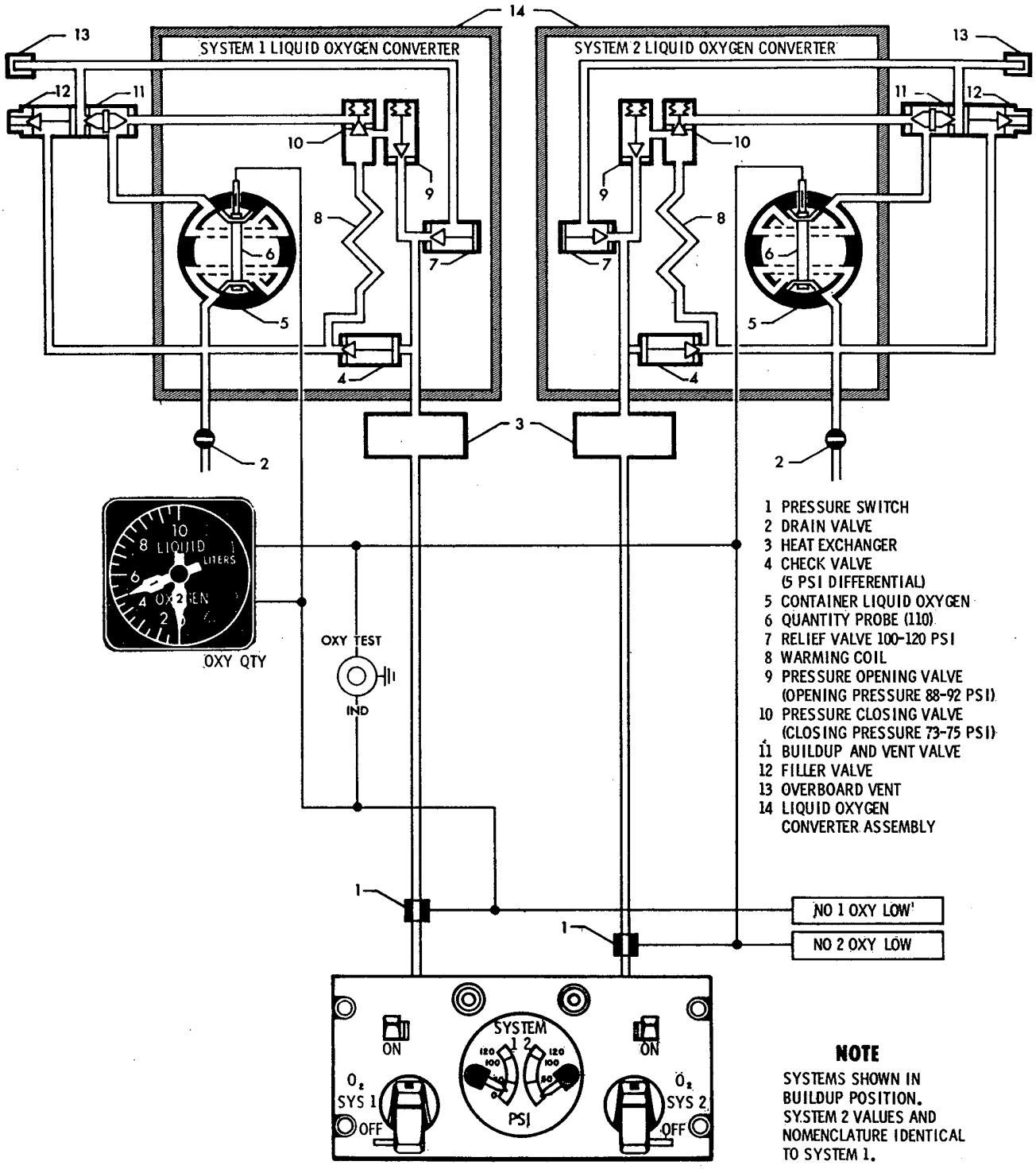
Nose Hatch Seal Shutoff Lever

A nose hatch seal shutoff lever, located on the forward right side of the cockpit, operates the nose hatch seal shutoff valve. It is normally in the ON position to allow canopy seal pressure to inflate the nose hatch seal. In the OFF position the nose hatch seal is isolated from the canopy seal system. This prevents the deflation of the cockpit canopy seal in the event of excessive nose hatch seal leakage.

Nose Air Shutoff Handle

A nose air shutoff T-handle is located at the bottom of the annunciator panel. It is normally in the locked ON position. The handle is turned counterclockwise to unlock and then pulled out to shut off airflow to the pressurized nose compartment.

LIQUID OXYGEN SYSTEM



F200-55(b)

Figure 1-34

OXYGEN SYSTEM AND PERSONAL EQUIPMENT

The aircraft is equipped with dual liquid oxygen systems. Two liquid oxygen converters located in the right side of the nosewheel well have a capacity of ten liters (2.6 gallons) each. The liquid oxygen flows, by gravity, into the pressure buildup coil and vaporizes because of exposure to ambient temperature surrounding the coils. The gas flows through the pressure closing portion of the pressure control valve and the buildup and gas ports of the fill valve and then back into the top of the container where it collects and develops into a higher pressure. This cycle continues until the system operating pressure is reached (80 $\pm$ 2 psi) at which time the pressure closing valve closes and stops the flow of liquid oxygen through the pressure buildup coil. The liquid oxygen will now flow through the check valve and out the converter supply port to the aircraft heat exchanger. During periods of shut down system pressure will continue to rise because of normal liquid boil off. The increase in pressure is sensed at the pressure opening valve. At 90 $\pm$ 2 psi this valve opens dumping the gas back into the converter. The pressure will continue to slowly rise, due to boil off, until it reaches reflief valve opening pressure of 100 to 120 psi. The excess pressure is vented overboard through the relief valve. Two ON-OFF levers for the two systems are located on the oxygen control installed on the left console. The needles on the pressure gage will fluctuate, indicating oxygen flow when the pilot inhales. Liquid oxygen is warmed and converted to gas for breathing by passing through a heat exchanger which consists of additional length of tubing in the supply line. The low pressure gage on the oxygen control panel indicates a normal pressure of 50-100 psi.

Liquid Oxygen Quantity Gage

The liquid oxygen quantity gage is located on the left side of the instrument panel. It is calibrated in 1/2 liter increments from 0 to 10. The quantity gage is a double needle type and indicates the quantity of liquid oxygen remaining in the No. 1 or No. 2 systems. When visible, a red OFF indicator at the bottom of the gage indicates the gage is not receiving power from the No. 1 inverter.

Indicator Test Switch

A red test button labeled IND TEST is located on the left side of the instrument panel. When this button is pressed the oxygen quantity gage needles will reduce indications. As the oxygen needles approach the 1 liter mark the OXY LOW warning light will illuminate. When the button is released the gage needles will resume their original position. The CIT and spike and forward bypass position indicators are also tested by this button.

Oxygen Low Indicating Lights

Two oxygen low warning lights are located on the pilot's annunciator panel. The lights are labeled NO. 1 OXY LOW and NO. 2 OXY LOW. Each light will illuminate when oxygen pressure drops to 58 $\pm$ 3 psi or when 1 liter or less remains in the system.

EMERGENCY OXYGEN SYSTEM

Two independent emergency oxygen systems are installed in the pilot's parachute pack. Each system consists of a 45 cubic inch, 2100 psi cylinder. The systems will supply oxygen simultaneously during bailout and when the aircraft oxygen systems fail. An oxygen line is routed around each side of the pilot's waist and connects to the suit controller valve. Emergency oxygen flow pressure is slightly lower than aircraft system pressure. Oxygen duration of each emergency system is approximately 15 minutes.

OXYGEN DURATION CHART

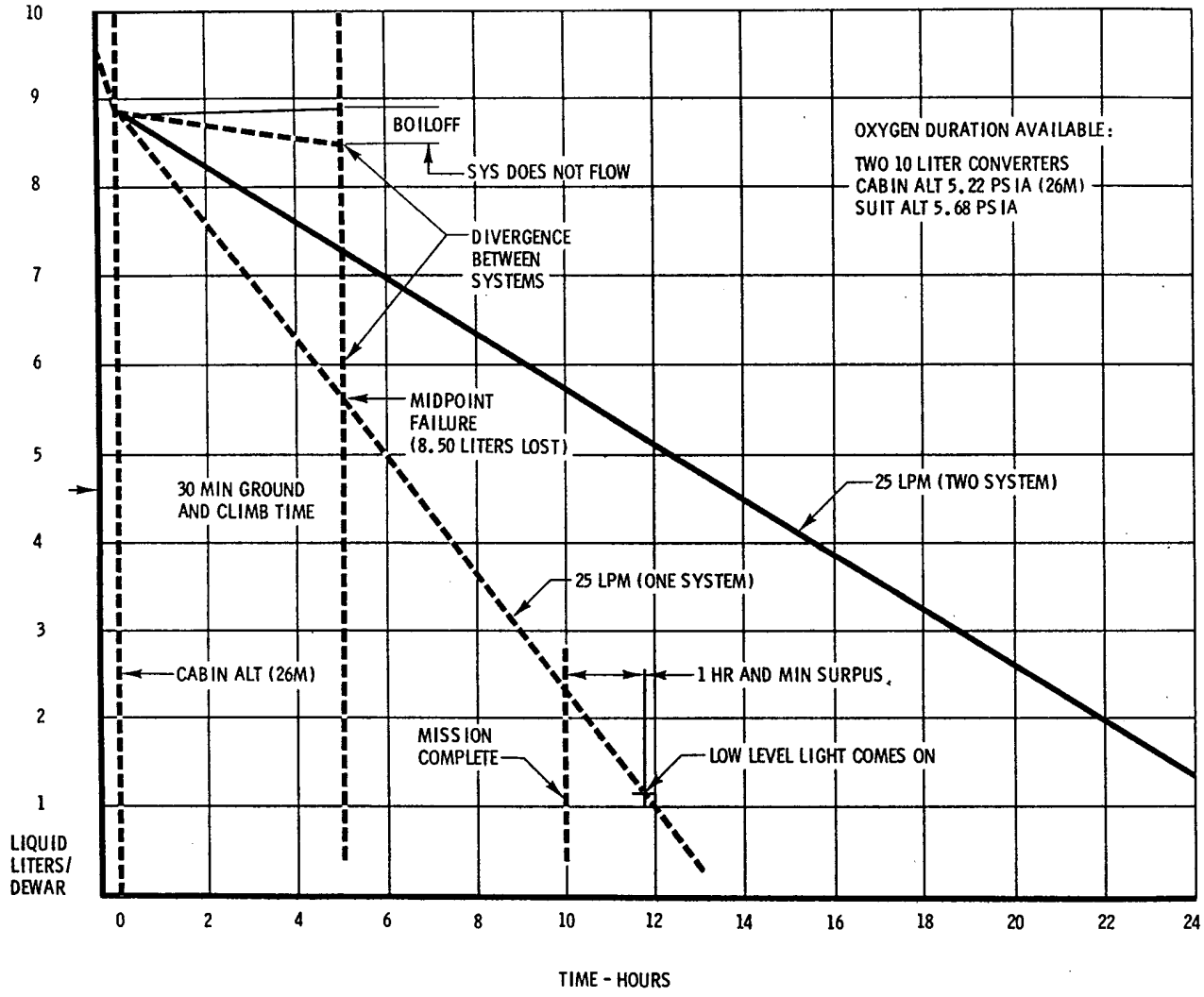


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Figure 1-35

The emergency oxygen system is actuated either manually by pulling the conventional green apple, or automatically by the upward motion of the seat during ejection. The emergency oxygen system should be actuated if the aircraft systems are not delivering the desired amount of oxygen or hypoxia or noxious fumes are suspected.

FULL PRESSURE SUIT

A full pressure suit is provided which is capable of furnishing the pilot with a safe environment regardless of pressure conditions in the cockpit. The suit consists of four layers, ventilation manifold, bladder, link net, and heat-reflective outer garment. The ventilation manifold layer allows vent air to circulate between the pilot's underwear and the bladder layer. The bladder provides an air-tight seal to hold pressurized air in the suit. The link net is a mesh which holds suit configuration in conformance with the pilot's body. The outer layer of heat-reflecting cloth provides some protection from a hot environment. Air pressure to the suit is regulated by a suit controller valve, located on the front of the suit just above the waist.

Pressure Suit Ventilation Air

Air for suit ventilation is provded by the cockpit air-conditioning system. Temperature of the ventilation air cannot be varied except by changing cockpit inlet air temperature. Ventilation airflow rate may be regulated by a suit flow control valve installed at the hose connection point on the suit. Ventilation air and exhaled breathing air are exhausted from the suit.

Suit Ventilation Boost Valve Lever

The suit ventilation boost valve lever, labeled SUIT VENTIL BOOST, is located on the left console. The lever is marked NORMAL (aft) and EMERG (forward). Operating the lever positions a butterfly valve in the cockpit air-conditioning air supply line in such a way as to vary the pressure of the air available to the suit system. Increased pressure results in more air to the suit. Moving the lever toward EMERG position progressively results in more pressure to the suit system by constricting the air-conditioning airflow to the cockpit; in the NORMAL position (used when engine rpm is high) the cockpit air-conditioning line requires no constriction to provide sufficient airflow to the suit. At IDLE engine rpm the ventilation boost valve lever must be kept at 2/3 of the way from NORMAL to EMERG in order to provide sufficient air for conditioning the suit and cooling the INS platform and inverters in the A/C bay. During takeoff and normal flight the valve lever is kept in the NORMAL position. If the pilot suffers discomfort, such as might happen with a gradual climb to an extreme altitude or during low-rpm descents, the valve lever is gradually moved toward the EMERG position until a comfortable pressure and ventilation condition is attained. The valve lever should not be moved toward EMERG more than necessary to provide pilot comfort; excessive suit system pressure will unduly reduce the available refrigeration.

Suit Controller Valve

All four aircraft and emergency oxygen system lines enter the controller valve at the front waist of the pressure suit. The controller valve contains a sensor that programs airflow and oxygen to keep internal

suit pressure at 3.5 psi (equivalent to pressure at 35,000 ft) in the event of cockpit depressurization. A press-to-test button for each oxygen system is installed on the controller valve, which allows the pilot to check suit inflation.

Face Plate Heat Switch

A face plate heat switch is installed on the right console of the cockpit. The switch has four positions; OFF, LOW, MED and HIGH. Heat may be regulated to defog the face plate as required. Defogging is accomplished by the combination of face plate heat and oxygen flow. The face plate heater circuit is powered by the essential dc bus.

HELMET

The helmet head area is divided into two separate sections by a rubberized cloth face seal. The front area between the face and the face seal receives oxygen from either the aircraft or emergency oxygen system through regulators built into the helmet. Oxygen flows across the face plate from the inhalation valves inside the helmet and accomplishes some face plate defogging before it is inhaled. The rear area receives vent air for helmet interior temperature regulation. The face seal is not positive; however, the pressure of the oxygen in the front area is slightly higher to prevent vent air from leaking forward. An external crank on the helmet is provided for head band adjustment. Buttons on each side of the helmet, when actuated, will lower the face plate and visor. The face plate is opened by moving the buttons and dumping the pressure, allowing the face plate to be rotated upward. If the aircraft or emergency oxygen supply to the helmet is interrupted or exhausted, the regulators in the helmet sense the drop in pressure and the face plate seal deflates, allowing ambient air to enter the helmet so the pilot will not suffocate.

GLOVES

Leather gloves fasten onto the suit at the wrist rings. The inner liner of the glove is similar to the suit inner liner and will retain pressure.

BOOTS

The sock or boot liner fastens onto the suit at the thigh by means of a zipper. The boots are made of white leather for heat reflection and fit snuggly over the socks. A spur that fastens to the seat is attached to each boot.

OXYGEN MASK AND REGULATOR

When permitted by appropriate regulations a substitute oxygen mask assembly may be used in place of a pressure suit for flights at low or intermediate altitudes. The assembly consists of a specially designed oxygen mask and F2700 oxygen regulator, anti-suffocation valve and two oxygen personal leads with connectors for both aircraft and emergency oxygen systems. In the event that the regulator should malfunction or the oxygen supply is exhausted, an anti-suffocation valve installed between the regulator and the mask will sense the drop in oxygen pressure and allow ambient air to enter the mask to prevent suffocation.

SURVIVAL KIT

A reinforced fiberglas survival kit container fits into the seat bucket and attaches to the parachute by snap attachments on each side. A door on the top provides access to the survival items stored inside. The kit contains standard survival items such as radio, flares, mirror, whistle, knife, matches, rations, water, compass and first aid kit. Various additional items depending on the terrain and season may be

provided. The kit is packed in a water proof bag attached to a 20 foot retention lanyard. If an overwater flight is anticipated, a life raft may be stowed on top of the plastic bag and attached to the lanyard. During ejection the life raft inflating device is armed. Following ejection, the survival kit release handle should be pulled before reaching the ground. This action separates the survival gear from the pilot and inflates the life raft. The survival gear and life raft remain attached to the parachute harness by the retention lanyard. During a rapid abandonment of the aircraft on the ground, the survival kit release handle may be used to free the pilot of the survival kit (including the lanyard) without inflating the life raft.

PARACHUTE

A special parachute with a 35 foot canopy is used. The large canopy provides a normal descent rate with the bulky personal equipment required for high altitude flight. A small diameter, ribbon type stabilizing drogue chute is also provided. Above 17,000 feet altitude, the drogue chute is deployed first in order to stabilize free fall of the pilot. The drogue is automatically jettisoned at 15,000 (± 400) feet after an aneroid controlled opener deploys the main chute. Below 16,200 feet the main chute only deploys immediately. A manual T-handle is also available for opening the main chute. The chute pack is equipped with conventional quick release buckles. The emergency oxygen bottles are located between the chute canopy and the pilot's back. A combination hand squeezed bulb and manually operated pressure relief valve located adjacent to the suit controller is used to adjust cushion pressure as desired. A red knob located on the left harness strap is connected to the parachute timer arming cable and is used to actuate the timer when bailout is made.

WINDSHIELD

The windshield is composed of two glass assemblies secured and sealed in a V-shaped titanium frame. The glass surfaces are coated with low reflective magnesium fluoride. A collapsible vision splitter is also installed on the windshield center line to minimize reflections.

DEFOG SYSTEM

The windshield defog system delivers hot air from both right and left air systems through check valves to defog the windshield and canopy. A plastic V-shaped air duct runs along the lower edge of the windshield. Hot defog air is supplied through this duct when selected by a switch that is located on the upper left console. The air is directed to the windshield through a series of holes on the upper surface of the duct. Holes are also provided at the aft ends of the duct to direct air toward the canopy glass.

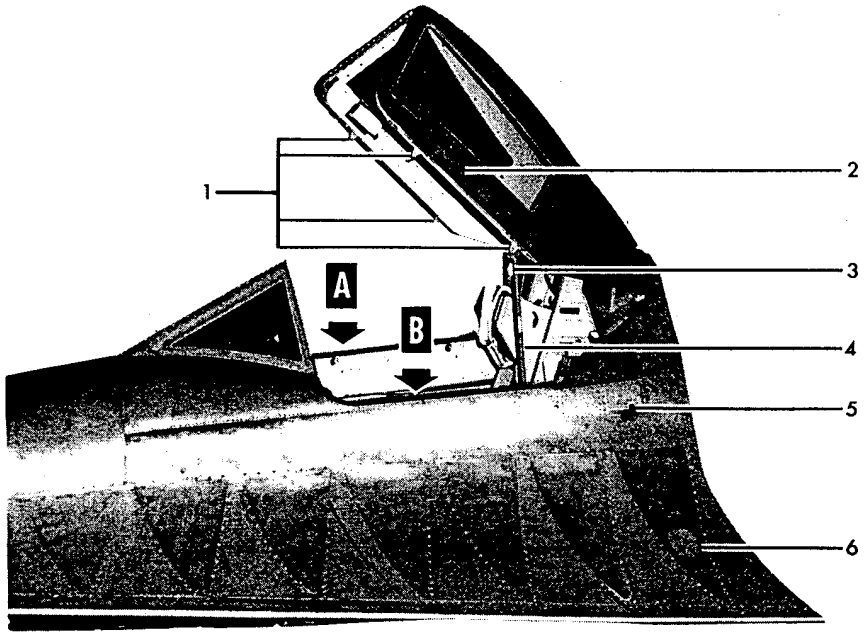
Defog Switch

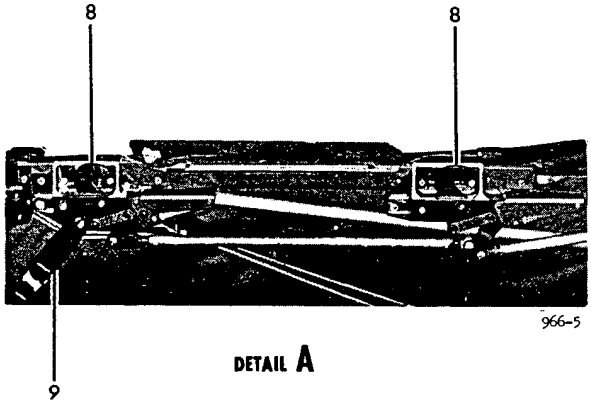
A three position defog switch is located at the forward end of the upper left console. When held in the momentary DEFOG INCREASE (forward) position the motor driven defog valve will open. Time of travel to full open is approximately 7 to 13 seconds. In the HOLD (center) position the valve will stop at any desired partial open position; in the OFF position the valve will completely close. The circuit is powered by the essential dc bus.

LEFT WINDSHIELD HOT AIR DEICING SYSTEM

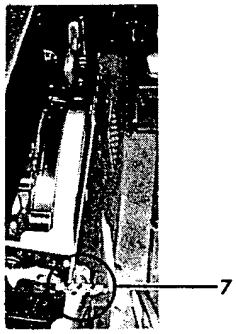
Hot air is ducted from the L & R pressurization supply downstream of the fuel air heat exchanger and upstream of the pressure regulator and air cycle refrigerator,

CANOPY AND CONTROLS





DETAIL A



DETAIL B

1 CANOPY LATCH ROLLER BRACKETS
2 CANOPY LIFTING HOLE
3 CANOPY PROP ASSEMBLY AND UPLOCK
4 CANOPY PROP (GROUND HANDLING)
5 CANOPY EXTERNAL LATCH CONTROL
6 CANOPY EXTERNAL JETTISON HANDLE
7 CANOPY INTERNAL JETTISON HANDLE
8 CANOPY LATCH HOOKS
9 CANOPY LATCH HANDLE

FMA12-36

Figure 1-36

to a series of orifices located on the left side of the outside center windshield support. The system includes left and right solenoid shutoff valves controlled by a switch in the cockpit. Power is furnished by the essentail dc bus.

Windshield Deice Switch and Indicator Light

The 3-position windshield deice switch is located on the upper left instrument panel. In the OFF (right) position the shutoff valves are closed and no deicing air is supplied. In the R ON (center) position the hot air is furnished by the right pressurization system and 1/2 flow is available for deicing. In the LR ON (left) position both L & R shutoff valves are opened and full flow is available to the windshield orifices. Power for the switch and lights is furnished by the dc essential bus.

NOTE

- A considerable amount of air is used when operating the deicing system in the L/R ON position. This may reduce the cockpit and Q-bay air supply when operating in the lower ranges of engine rpm.
- The deicer indicator light, located above the switch, will be illuminated at any time the deice switch is not in the OFF position.

WINDSHIELD RAIN REMOVAL SYSTEM

A rain removal system is provided for clearing the windshield when operating the aircraft in rain. It has a tank that is pressurized by air from the windshield deicer system and the tank is connected to a spray tube located on the left side of the windshield center divider. A pushbutton switch, located on the upper instrument panel, is used to spray the rain removal fluid onto the left windshield. Power is furnished by the essential dc bus.

CAUTION

Do not apply rain repellent on a dry windshield as prolonged obscuration may result.

CANOPY

The canopy consists of two high temperature resistant glass windows secured within a reinforced titanium frame which is hinged at the aft end of two hinge pins. Operation of the canopy is completely manual. Small holes in each side of the canopy are provided as lifting points from the outside. No handles are provided on the inside of the canopy for moving it up or down. A prop assembly locks the canopy in the full open position. The canopy is secured in the closed and locked position by a four hook interconnected latching mechanism. A nitrogen boost counterbalancing system is provided to aid in the manual opening and closing of the canopy. This nitrogen is also used to force water into the map case when the destruct system is actuated.

NOTE

Actuation of the destruct system tends to deplete the nitrogen boost counterbalance system and increase the manual force needed to open the canopy. Canopy jettisoning may be necessary for rapid egress.

An internal latching handle is installed below the right canopy sill, allowing the canopy to be latched from the inside. An external fitting located on the left side of the aircraft can be used to operate the latches from the outside.

CAUTION

The canopy should be opened or closed only when the aircraft is completely stopped. Maximum taxi speed with the canopy open is 40 knots. Gusts or severe wind condition should be considered as a portion of the 40 knot limit.

Canopy Latch Handle

A canopy latch handle is located under the right sill in the cockpit and rotates forward to lock. The sill trim is cutout to expose the action of the locking lugs and pins as the handle is rotated forward. A cam over center action allows the handle to remain only in the latched or unlatched position. No canopy unsafe warning light is provided.

Canopy External Latch Control

A flush mounted external latch fitting is located on the left side of the aircraft and permits the canopy to be opened from the outside. The fitting accepts a 1/2 inch square bar extension. Once the canopy is unlocked, it may be raised manually until the prop locks it in the open position.

Canopy External Jettison Handle

The canopy external jettison handle, located beneath an access panel on top of the left chine, permits ground rescue personnel to jettison the canopy. Sufficient cable length is provided to allow the operator to stand clear of the fuselage during the jettisoning procedure.

Canopy Internal Jettison Handle

A canopy jettison T-handle is located on the left console wall adjacent to the pilot's leg. The handle can be used to jettison the canopy without initiating the seat ejection system. The handle is held in the stowed position by a lockwire and a ground safety pin. Storage for the canopy jettison and seat safety pins is provided at the forward end of the upper right console. Cable travel is approximately six inches.

CANOPY SEAL

An inflatable rubber seal is installed in the edge of the canopy frame. The seal seats against the mating surfaces of the canopy sill and windshield to provide sealing for cockpit pressurization. The canopy seal pressurization lever above the forward right console operates the seal inflation valve. A nose hatch seal shutoff lever is also provided to prevent deflation of the canopy seal in the event of nose hatch seal leakage.

CANOPY JETTISON SEQUENCE

The canopy jettison system is designed to unlatch and jettison the canopy from the aircraft by means of explosive initiators and thrusters. The system consists of two initiators which are independently actuated by either the ejection seat D-ring or the canopy jettison handle, a canopy unlatch thruster, a canopy removal thruster, a canopy seal hose cutter, cable linkage and gas pressure lines. Either the D-ring initiator or the canopy initiator or the canopy initiator will fire the unlatch thruster which unlocks the canopy. This thruster then activates the canopy seal hose cutter and fires the canopy removal thruster which jettisons the canopy. Whenever the canopy is jettisoned by use of the canopy jettison handle, the canopy jettison initiator gas pressure positions a seat jettison safety valve to prevent initiating the seat ejection sequence until the D-ring is pulled. Pulling the D-ring jettisons the canopy as the initial step in the ejection sequence.

REAR VIEW PERISCOPE

A manually extended rear view periscope is mounted in the top of the canopy to enable the pilot to see the engine nacelles and rear fuselage and rudder area. The periscope,

normally is locked in a fully retracted position. It is moved by using the white nylon pad, mounted on the aft side of the viewing tube, as a handle. Pushing the handle to the left unlocks the tube, allowing the periscope to be extended. Then, pushing the tube upward to a spring-detented position makes the rear view available. Cockpit pressure tends to assist extension, and resists retraction. The diameter of the instantaneous cone of view is approximately 10°; however, head movement extends the viewing cone to approximately 30° total angle. When extended, the periscope can be rotated horizontally to move the center of the viewing arc up to 10° from the aft centerline. The de-magnification ratio of the lens system is 1 to 0.5.

EJECTION SEAT

The ejection seat system utilizes an upward catapult and rocket thrust to provide minimum risk ejection capability at ground level when airspeed is at least 65 KIAS. The seat incorporates an ejection ring, headrest, knee guards, automatic foot retractors, automatic foot retention separation, a pilot-seat separation device, shoulder harness, inertia reel lock assembly, and an automatic opening seat belt. A speed sensor mounted on the fuselage behind the seat automatically selects one of two seat separation delays, depending upon airspeed at ejection. (Refer to Ejection Sequence this section.) Quick disconnect fittings installed on the seat rails and the floor of the aircraft permit disconnection of the oxygen, ventilated suit and electrical lines.

Seat Vertical Adjustment Switch

The seat may be adjusted vertically by means of an electric actuator mounted on the lower end of the catapult. The three-position switch is located on the right side of the seat bucket. The seat moves in the direction the switch is moved. Power for seat adjustment is furnished by the essential dc bus.

Shoulder Harness Inertia Reel Lock Lever

A shoulder harness inertia reel lock lever installed on the left side of the seat bucket is provided for locking and unlocking the shoulder harness. The lever has two positions, LOCK and UNLOCK. Each position is spring loaded to hold the lever in the selected position. An inertia reel located on the back of the seat will maintain a constant tension on the shoulder straps to keep them from becoming slack during backward movement. The reel also incorporates a locking mechanism which will lock the shoulder harness when a 2 to 3 g force has been exerted in a forward direction. When the reel is locked in this manner, it will remain locked until the lever is moved to the LOCK position and then returned to the UNLOCK position.

Ejection (D) Ring

An ejection ring, located on the front of the seat bucket, is the primary control for ejection. An ejection safety pin is installed in the ejection ring housing bracket.

Ejection T-Handle

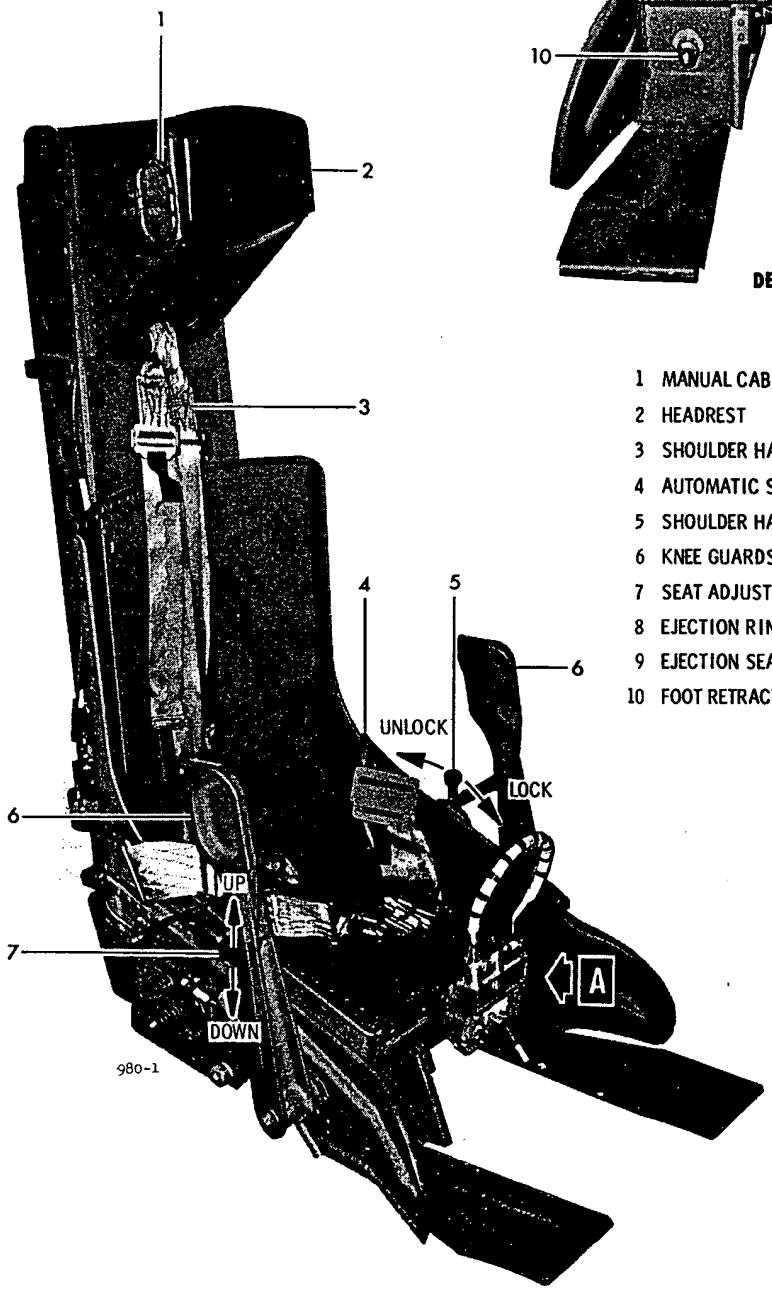
The aircraft are equipped with a backup secondary seat ejection system. The T-handle for this seat ejection system is unlocked and made accessible only by first pulling the ejection D-ring.

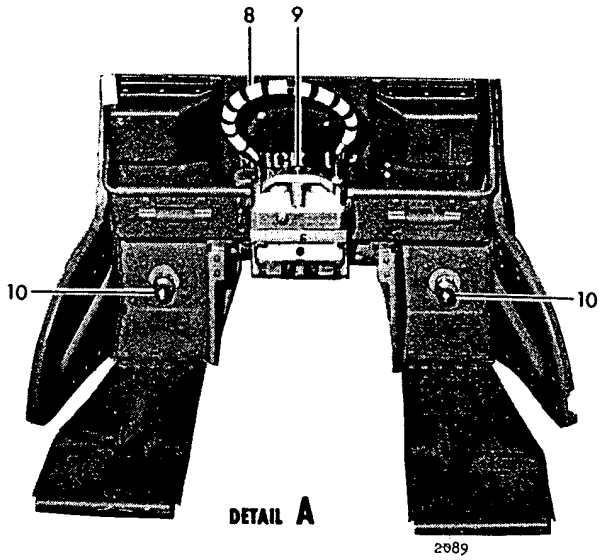
WARNING

The ejection seat must not be fired by pulling the T-handle while the canopy is still in place. The pilot can not eject through the metal canopy.

When the secondary ejection T-handle is pulled a separate initiator fires the seat catapult and seat separation and belt opening initiator.

EJECTION SEAT





1 MANUAL CABLE CUTTER RING
2 HEADREST
3 SHOULDER HARNESS
4 AUTOMATIC SEAT BELT
5 SHOULDER HARNESS INERTIA REEL LOCK LEVER
6 KNEE GUARDS
7 SEAT ADJUSTMENT SWITCH
8 EJECTION RING
9 EJECTION SEAT T HANDLE
10 FOOT RETRACTOR FITTINGS

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F200-28(b)

Figure 1-37

Foot Spurs

Foot spurs, attached to the pilot's shoes, are attached to the ejection seat by cables. Normal foot movement is in no way restricted since the cables, under a slight spring tension, reel in and out freely. When the ejection ring is pulled, the knee guards rotate from their stowed position, the cables to the foot spurs are reeled in and the pilot's feet are retracted into the foot rests. The foot cables are automatically severed by a set of cutters as part of the ejection sequence.

Manual Cable Cutter Ring

The ejection seat incorporates an emergency means for cutting the foot retractor cables. A D-ring, located to the right of the seat headrest, will actuate the cable cutters initiator if the automatic cable cutter system fails or rapid abandonment of the aircraft is required on the ground.

PILOT-SEAT SEPARATION SYSTEM

The ejection seat is provided with a pilot-seat separation system which operates in conjunction with the automatic seat belt release system. A windup reel is mounted behind the headrest, and a single nylon web is routed from the reel to halfway down the forward face of the seat back. From this point two separate nylon straps continue down, pass under the survival kit, and are secured to the forward seat bucket lip. After ejection, as the seat belt is released, an initiator actuates the windup reel which winds the webbing onto a cross-shaft, pulls the webbing taut, and causes the pilot to be separated from the seat with a sling shot action.

AUTOMATIC SEAT BELT

The ejection seat is equipped with an automatic opening seat belt which facilitates pilot separation from the seat following ejection. Belt opening is accomplished automatically as part of the ejection sequence and requires no additional effort on the part of the pilot.

SEAT BELT-PARACHUTE ATTACHMENT

If the pilot is wearing an automatic opening aneroid type parachute, the parachute lanyard anchor from the parachute aneroid must be attached to the swivel link. As the pilot separates from the seat, the lanyard, which is anchored to the belt, serves as a static line to arm the parachute aneroid. The parachute aneroid preset altitude is approximately 15,000 feet.

EJECTION SEQUENCE

Pulling the D-ring is normally the only action required to initiate pilot ejection and results in firing both the canopy jettison and ejection seat systems. All resultant actions will occur automatically and in a specific sequence as explained below.

The D-ring cable fires the ejection sequence initiator, actuating the canopy jettison system and the leg guard thruster. The leg guard thruster rotates the knee guards, retracts the pilot's feet, activates the cable cutter backup initiator and locks the shoulder harness. Movement of the canopy jettison thruster (final step in canopy jettison sequence) actuates an initiator which fires a 0.3 second delay catapult initiator and arms the speed sensor. The 0.3 second delay assures complete canopy separation prior to seat ejection. Gas pressure from the catapult initiator fires the rocket-catapult,

the 4-second seat separation delay initiator, and enters the speed sensor. If airspeed is below 295 KIAS, the gas pressure passes through the speed sensor and fires the 1.0 second delay seat separation initiator. If airspeed is above 302 KIAS, the pressure is blocked by the speed sensor.

Initial seat movement upward on the rails disconnects normal oxygen, ventilated suit and electrical lines, and activates the emergency oxygen supply. Between 295 and 302 KIAS either the 1 or 4 second delay may be experienced because of the speed sensor tolerance.

Either the 1.0 second delay initiator (below 295 KIAS) or the 4-second delay initiator (above 302 KIAS) actuates the cable cutters, releases the pilot's feet, opens the seat belt and fires the seat separation system.

A static line attached to the seat belt is pulled as the pilot separates from the seat and activates the automatic parachute sequence.

If the normal D-ring ejection sequence was not accomplished, the canopy must be jettisoned either by use of the canopy jettison system or manually. Pulling the T-handle initiates the secondary seat ejection sequence.

CAUTION

The T-handle backup ejection sequence does not rotate the knee guards nor retract the foot cables. Seat separation delay time will be 4 seconds regardless of airspeed.

NORMAL PROCEDURES

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PREPARATION FOR FLIGHT

FLIGHT RESTRICTIONS

Refer to Section V for Operating Restrictions and Limitations.

FLIGHT PLANNING

Refer to Appendix I.

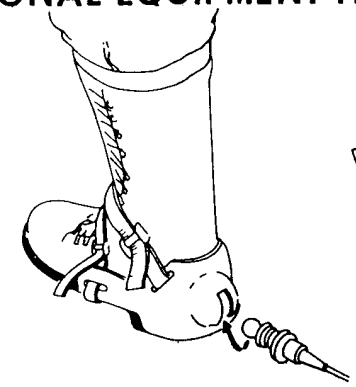
TAKEOFF AND LANDING DATA

Refer to Appendix I for Takeoff and Landing information.

WEIGHT AND BALANCE

Refer to Section V for Weight and Balance Limitations. For detailed loading information, refer to Handbook of Weight and Balance Data. Before each flight, check takeoff and anticipated landing gross weights and weight and balance clearance (Form 365F).

PERSONAL EQUIPMENT HOOKUP

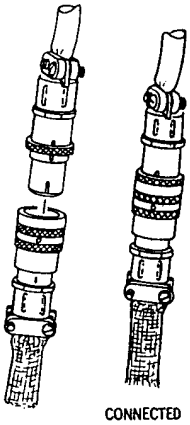


1 HOOK UP SPURS

FOOT SPURS WILL BE ATTACHED AND REMOVED BY PILOT FROM A STANDING POSITION UPON ENTERING AND LEAVING COCKPIT

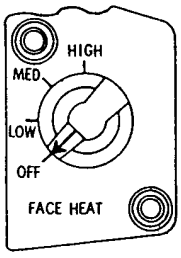
CAUTION

PERSONAL EQUIPMENT TECHNICIAN WILL ASSIST IN ATTACHING SPURS AND BALL FITTING BY HAND IF REQUESTED

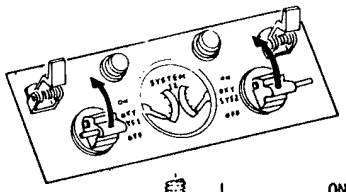


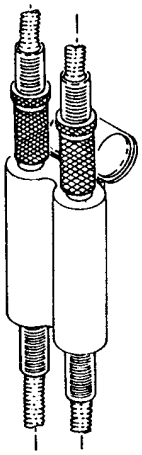
DISCONNECTED CONNECTED

2 COMMUNICATIONS (FACE HEAT AND RADIO) CONNECT HELMET CHORD TO PARACHUTE EXTENSION CHORD



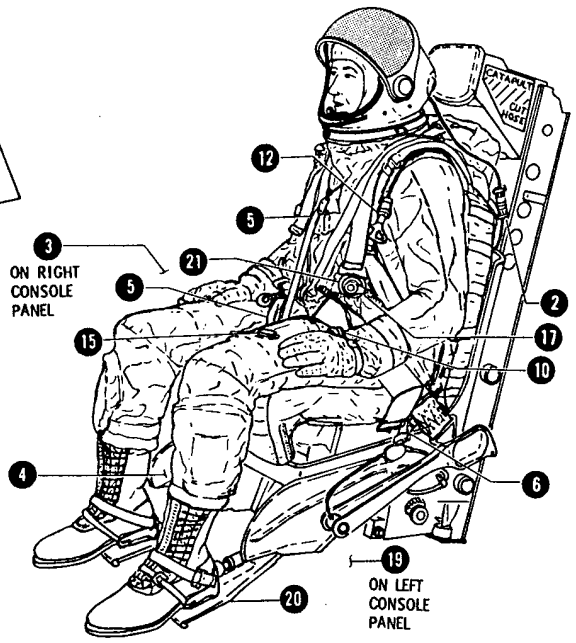
3 TURN FACE HEAT ON LOW (CONTROL ON RIGHT HAND CONSOLE)

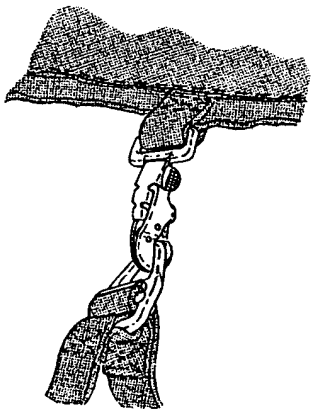




4 SECURE OXYGEN PERSONAL LEAD HOSES IN QUICK DISCONNECT (INSIDE FRONT OF SEAT BUCKET)

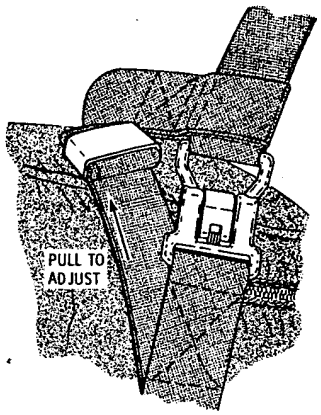
- a INSTALL NO. 2 HOSE CONNECTION AND TURN PRESSURE ON
- b INSTALL NO. 1 HOSE CONNECTION AND TURN PRESSURE ON
- c CHECK PRESSURE 65 TO 100 PSI



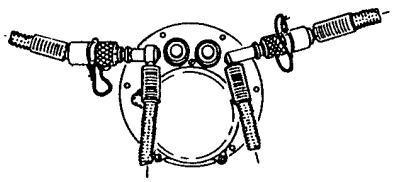


5 CONNECT PARACHUTE HARNESS, THREE PLACES

- a CHEST STRAP (UNDER HELMET HOLD DOWN LANYARD)
- b RIGHT LEG STRAP (OVER PERSONAL OXYGEN LEAD HOSES)
- c LEFT LEG STRAP



6 ADJUST KIT SEAT STRAPS; RIGHT AND LEFT SIDE



7 CONNECT EMERGENCY OXYGEN HOSES, SLIDE KNURLED FITTING INTO PLACE, INSERT SAFETY CLIP, PULL ON HOSE SLIGHTY TO ASSURE OF LOCKED POSITION

NOTE

LEFT HOSE OVER HELMET HOLD DOWN STRAP

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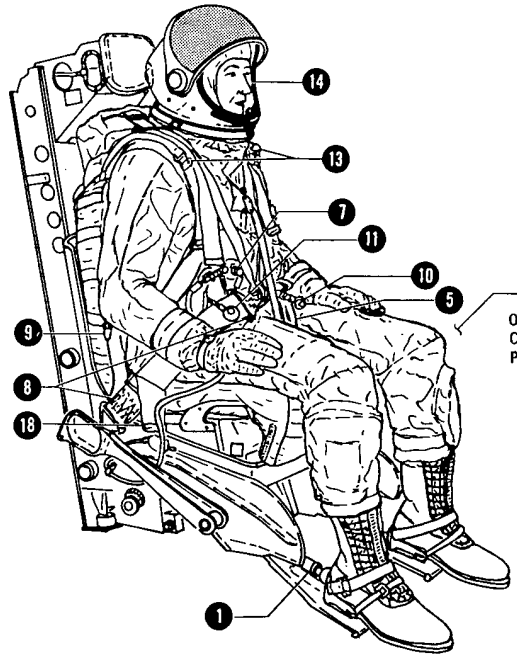
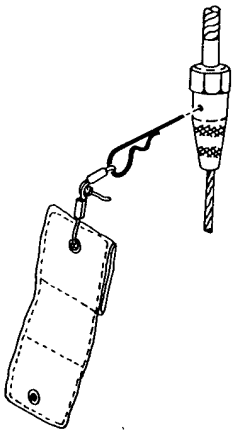
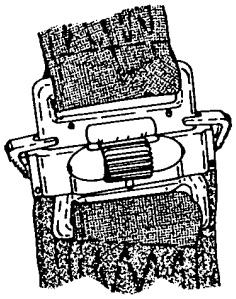
Figure 2-1 (Sheet 1 of 2)

PERSONAL EQUIPMENT HOOKUP



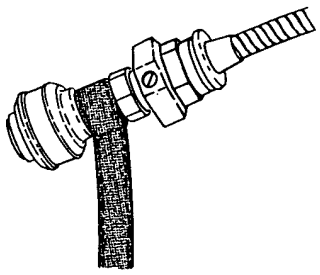


9 CHECK EMERGENCY OXYGEN CABLE AND REMOVE SAFETY PIN



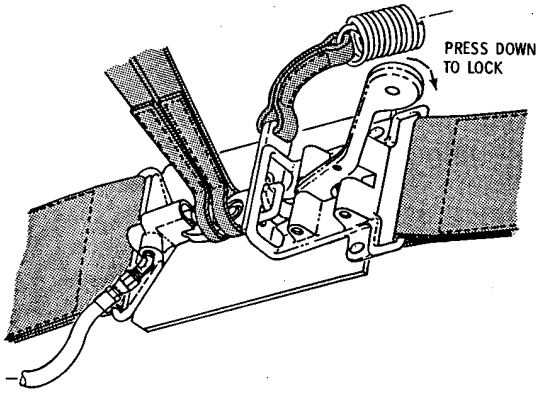
13 CHECK (TWO) PARACHUTE CANOPY ROCKET JET RELEASES. INSURE ROLL BAR PIN IS IN DOWN (LOCKED) POSITION. PULL ON EACH RELEASE TO INSURE LOCK POSITION

14 CHECK FACE HEAT, PLACE BACK OF HAND ON VISOR



15 CONNECT HEAT PROBE (IF APPLICABLE)

16 PRESS TO TEST BOTH SUIT EMERGENCY PRESSURIZATION SYSTEMS, (SEE ILLUSTRATION NO. 7) ONE AT A TIME. CHECK PRESSURE, APPROXIMATELY 65 TO 100 PSI AND FLUCTUATING



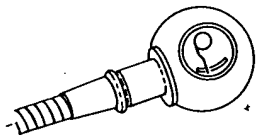
10 CHECK PARACHUTE ARMING (RED KNOB) KNOB IS SECURED INTO DETENT

17 CHECK ACCESSIBILITY OF SUIT FLOATATION KNOB PULL TAB

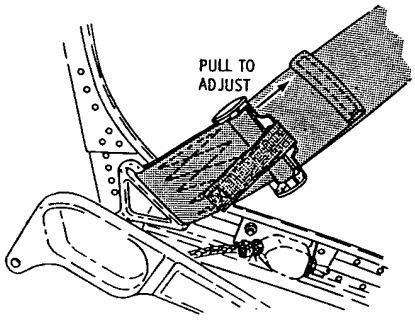
18 READJUST LAP BELT

19 CHECK OXYGEN QUANTITY, BOTH SYSTEMS

20 CHECK FOOT REST GUARDS

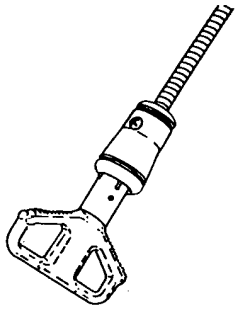


11 CHECK ACCESSIBILITY OF EMERGENCY OXYGEN ACTUATOR (GREEN APPLE) 1800 PSI MINIMUM BOTH SYSTEMS. INSURE GREEN APPLE IS SNAPPED SECURE INTO DETENT

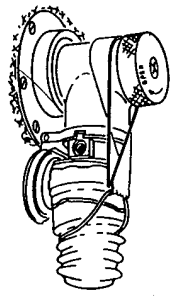


8 LAP BELT

SECURE SHOULDER HARNESS STRAPS AND PARACHUTE TIMER ARMING KEY. LOCK BELT AND ADJUST



12 CHECK PARACHUTE MANUAL "T" HANDLE. INSURE HANDLE IS SNAPPED SECURE INTO HOUSING



21 CONNECT VENT HOSE

NOTE

THIS WILL BE ACCOMPLISHED AFTER ENGINES ARE RUNNING UNLESS EXTERNAL AIR CONDITION VENTILATION UNIT IS HOOKED TO AIRCRAFT VENT SYSTEM. PULL DOWN ON VENT HOSE CONNECTION TO INSURE LOCK POSITION

F200-72(2)(d)

Figure 2-1 (Sheet 2 of 2)

AIRCRAFT STATUS

Refer to Form 781 for engineering, servicing, and equipment status.

EXTERIOR INSPECTION

It is not practical for the pilot to perform an exterior inspection while wearing a pressure suit. The exterior inspection should be accomplished by other qualified personnel.

PREFLIGHT CHECK

ENTRANCE

A ladder platform stand which overhangs the chine is used to gain entrance to the cockpit. The canopy is unlatched externally by rotating the external canopy control clockwise with an L-shaped 1/2 inch square bar. The canopy is manually raised to the full open latched position.

BEFORE ENTERING COCKPIT

1. Manual cable cutter ring - Secure.
2. Ejection seat and canopy safety pins installed - Check.

INTERIOR CHECK

1. All circuit breakers - In.
2. Foot retractors - Attach.
3. Throttles - OFF.
4. Landing gear lever - DOWN.
5. Battery switch - EXT PWR.
6. Accomplish and check personal equipment hookup. (Hookup will be performed by personal equipment personnel). Refer to figure 2-1.
7. Suit vent boost lever - Set at 2/3 lever travel.

Left Console

1. IFF - ON. Set to proper mode and code.
2. Panel and instrument lights switches - As desired.
3. COMM selector switch - UHF.
4. External light selector switch - OFF.
5. Defog switch - OFF.
6. HF radio - OFF.
7. UHF radio - OFF.
8. Throttle friction lever - As desired.
9. TEB counter - Check 12.
10. Aft bypass switches - Both CLOSED.

Instrument Panel

1. Cabin Q-bay altitude selector lever - CABIN.
2. Landing and taxi light switch - OFF.
3. Brake switch - ANTI-SKID.
4. Cockpit temperature switch - AUTO.
5. Q-bay temperature switch - AUTO.
6. Q-bay air switch - ON.

7. Cockpit and Q-bay auto temperature rheostats - As desired.
8. Cockpit and Q-bay temperature indicator switch - Q-BAY.
9. Cockpit air switch - ON.
10. Pressure dump switch - OFF.
11. Drag chute handle - Stowed.
12. Windshield deicer switch - OFF.
13. Clocks - Check.
14. Compressor inlet temperature gage - Check needles together and indicating ambient temperature.
15. Igniter purge switch - OFF (down).
16. Compressor inlet static pressure gage - Check needles together and indicating barometric pressure.
17. TDI - Check for proper indication.
18. Altimeter - Set.
19. Periscope MIR SEL handle - Full forward - (Projector).
20. Fuel derichment arming switch - OFF.
21. Restart switches - OFF.
22. Spike knobs - AUTO.
23. Inlet air forward bypass knobs - AUTO.
24. Emergency fuel shutoff switches - Fuel On (guards down).
25. Cockpit pressure schedule switch - As desired.
26. Spike and forward bypass position indicators - Check.
27. Fuel transfer switch - OFF (guard down).
28. Fuel dump switch - OFF (guard down).
29. ILS receiver - OFF.
30. Air refuel switch - OFF.
31. Destruct switch - OFF (guard down).

Right Console

1. Nose hatch seal pressure lever - ON.
2. Pitot pressure selector lever - NORMAL.
3. Canopy seal pressure lever - OFF.
4. Stability augmentation switches - OFF.
5. Autopilot switches - OFF.
6. Inertial navigation system panel - As required.
7. Autopilot and attitude reference selector switch - As desired.
8. BDHI needle selector switch - TACAN.
9. TACAN switches - T/R and tuned to desired station.
10. ADF receiver switch - ANT.
11. Floodlight switch - As desired.
12. Face plate heat switch - As desired.
13. Flight reference system (FRS) compass select switch - MAG.
14. [ ] and SIP power switches - OFF.

Lower Instrument Panel

1. Surface limit release handle - Pulled out.
2. Pitot heat switch - OFF.
3. Hydraulic reserve oil switch - OFF (guard down).
4. Trim power switch - ON.
5. Nose air conditioning handle - Stowed.
6. Backup pitch damper switch - OFF (guard down).
7. Pitch logic override switch - OFF (guard down).
8. Yaw logic override switch - OFF (guard down).
9. Gear release handle - Stowed.

EQUIPMENT FUNCTION CHECK

1. Inverter switches - NORM.
2. N_2 and tank lights switch - Test.
   a. N_2 quantity indicators should decrease to zero.
   b. N QTY LOW warning light should illluminate.
3. Crossfeed and boost pump switches - Press lights on.
4. Pump release switch - PUMP REL, then release.
5. Tank boost pumps - Check 1, 2 and 6 TANK lights on (automatic sequencing).
6. Crossfeed switch - Press (check light off).
7. Fuel quantity indicating system - Check.
   a. Individual (1, 2, 3, 4, 5 and 6) tank quantities - Check.
   b. Total fuel quantity - Check.
8. Gear and warning lights test switch - Press.
   a. All warning and fire lights should illuminate.
   b. Landing gear unsafe warning horn should sound.
9. IND TEST button - Press.
   a. Oxygen quantity needles will move to below 0.
   b. CIT indicator will decrease toward zero.
   c. Spike and forward bypass position indicators increase to maximum forward indication on spike and maximum open on forward bypass.
10. Headset plug and oxygen mask - Connect (if pressure suit is not used).
11. No. 1 and No. 2 oxygen systems - ON (if pressure suit is not used). Check system pressures.
12. Tape and flight recorders - ON.

STARTING ENGINES

CAUTION

Before starting an engine, determine that the wheels are firmly chocked since brakes are inoperable until hydraulic pressure is available and no parking brake is installed.

. Determine that intake and exhaust areas are clear of personnel and ground equipment. The ground personnel using interphone communication equipment will be in position to observe the exhaust nozzle and nacelle inspection panels during starting.

. Do not move the control stick until at least 1500 psi hydraulic pressure can be maintained on the A or B system gages or a control system inspection will be necessary.

1. Check with INS crew prior to starting engines.

2. Fuel low pressure lights - Off.

3. Engine instruments - Check.

4. Ground starting unit - Instruct ground crew to rotate engine for start.

5. Throttle - IDLE when rpm is indicated.

6. Fuel flow - Check 1500-2000 pph.

7. Engine light up will be indicated in approximately 15 seconds by a continuous rpm increase and by a rise in EGT.

8. EGT - Check for 540°C max during acceleration.

NOTE

If engine does not accelerate smoothly to 3550-3650 rpm, retard throttle to OFF and then quickly advance to IDLE. This "double clutching" momentarily leans the fuel:air mixture and properly positions the flame front in the burner cans. Count as another TEB shot.

9. Ground starting unit - Signal ground crew for starter OFF at 3200-3300 rpm.

10. Idle rpm - Check 3550-3650 rpm.

NOTE

Idle rpm increases 50 rpm per °C above 32°C (90°F).

11. Engine and hydraulic pressure instruments - Check normal.

    a. Fuel flow - Check (approximately 3300 pounds per hour).

    b. EGT - Check (350°-540°C).

    c. Oil pressure indicator - Check.

CAUTION

Discontinue start if oil pressure rise is not observed within 60 seconds from start of rotation.

    d. Hydraulic system pressures - Check.

12. UHF switch - BOTH.

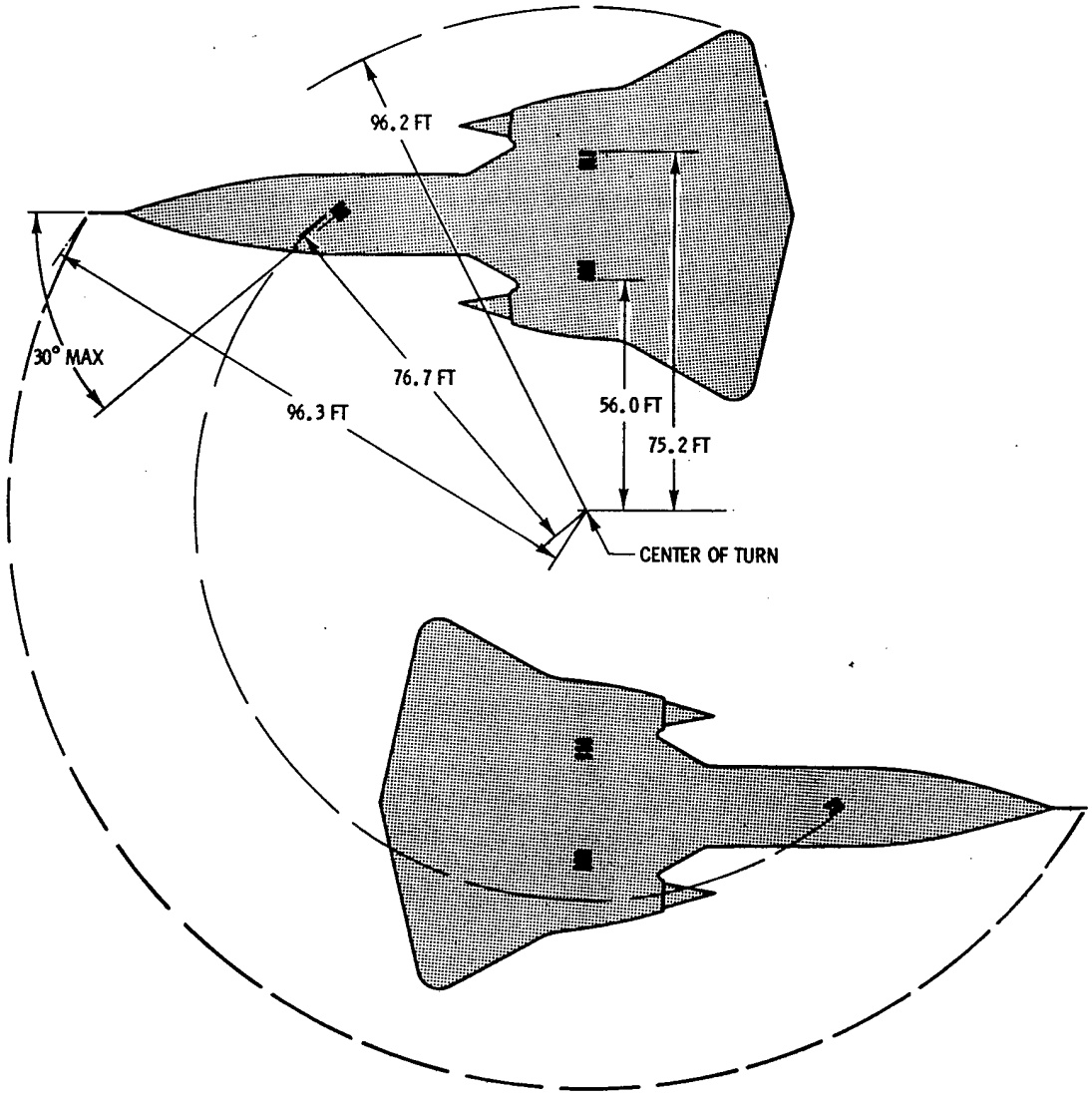
13. Start other engine using above procedure.

14. TEB counter - Check.

CAUTION

If throttle is inadvertently retarded to OFF do not advance in an attempt to restart engine. In case of false start use engine clearing procedures, this section. Afterburner duct must be visually checked and unburned fuel removed prior to attempting another start.

TURNING DIAGRAM



NOTE: 151.9 FT MINIMUM RUNWAY WIDTH REQUIRED FOR 180-DEGREE TURN (MAIN GEAR WHEELS ON EDGE OF RUNWAY AT START OF TURN).

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FM-61(a)

Figure 2-2

CLEARING ENGINE

When a false start occurs, trapped fuel and fuel vapor may be removed from engine by using the following procedure:

1. Throttle - OFF.
2. Ground starting unit - ON for approximately 1 minute. Then signal ground crew for ground starting unit - OFF.

CAUTION

Do not rotate the engine with fuel shut off (Emergency Fuel Shutoff switch - UP, Guard up) except in case of emergency, because damage to the engine may result.

BEFORE TAXIING

1. UHF and IFF/SIF - Check.
2. IFF - As required.
3. Generator switches - RESET (momentary) at idle rpm. Check with INS crew prior to resetting.
4. Battery switch - BAT (within 3 seconds).
5. Generator out lights - Check Off.

NOTE

If the generator out warning lights fail to extinguish, return the battery switch to the EXT PWR position and repeat steps 3 and 4 above.

6. INS DEST/FIX switch - VARIABLE DEST.
7. INS mode switch - NAV. Check with INS crew prior to actuating switch. Press the STORE button and check BDHI No. 2 steering needle for 10° right indication and Distance To Go indicator for 122 nautical mile readout.
8. INS indications - Report Destination Coordinates, Distance To Go and Groundspeed when slewing is completed.
9. INS DEST/FIX switch - Select VARIABLE FIX and press STORE button. Check INS FIX REJECT light on.
10. INS DEST/FIX switch - Select VARIABLE DEST and press STORE button. Check INS FIX REJECT light off.
11. INS umbilical cord - Check disconnected (confirmed by INS crew).
12. External power - Signal for disconnect.
13. Inlet air forward bypass - Check open. Ground crew will confirm open.
14. HF radio - ON.
15. SAS channel switches - All ON.
16. SAS recycle lights - Press (all lights should go out).
17. SAS light test switch - Press (all lights should illuminate).
18. Autopilot pitch and roll engage switches - ON.
19. Autopilot disengage switch (control stick)- Press. Check that autopilot disengages.
20. SAS channel switches - OFF. Pitch and yaw A and B and Roll disengage lights illuminate. Both MON lights must stay out.

21. Surface trim - Check for proper operation with ground crew and set to zero.

22. Control system - Check for proper direction of movement. Individually check each axis in both directions and have ground personnel verify proper deflection of control surfaces.

23. Package switches - As required.

24. Canopy and seat safety pins - Remove and stow.

25. Canopy - Close and lock.

26. Canopy seal pressure lever - ON.

CAUTION

The canopy should be opened or closed only when the aircraft is completely stopped. Maximum taxi speed with the canopy open is approximately 40 knots. Gust or severe wind conditions should be considered as a portion of the 40 knot limit taxi speed.

27. Rear view periscope - Check.

28. Taxi clearance - Obtain clearance from control tower.

29. Chocks and downlock pins - Signal for removal. Observe ground crew for clearance to taxi.

30. Nosewheel steering - Engage and check operation.

TAXIING

1. Brakes - Check.

WARNING

Do not switch to alternate brakes with both L & R hydraulic systems operative.

2. Flight instruments - Check.

3. Navigation equipment - Check operation of ADF, TACAN, and INS.

CAUTION

All taxiing and turns should be accomplished at slow speeds so as to limit side loads on the landing gear. Fast taxiing should also be avoided to prevent excessive brake and tire heating and wear.

BEFORE TAKEOFF

1. Engine trim - As required.

NOTE

If engine trim run is required, EGT values appropriate for ambient temperature will be supplied during preparation for flight.

During trim run at Military rpm:

2. Cockpit and Q-bay auto temp controls - Adjust if necessary.

NOTE

Adjust both controls toward increasing temperature positions if necessary, to eliminate cockpit fog if fog is encountered at lower temperature settings. 12:00 to 1:00 o'clock settings are normally sufficient. Lower temperature settings are desirable when local humidity and ambient temperature conditions permit, in order to assure personal and equipment cooling.

3. SAS channel switches - All ON.

4. SAS recycle lights - Press, if necessary (lights should go out).

5. Surface trim indicators - Check for zero setting.

6. Tanks 1, 2 and 6 - Check ON.

7. INS - Check and fix as required. At designated runway position, select correct STORED FIX position and fix. Check INS FIX REJECT light off. Select STORED MAN. Reset DEST/FIX briefed initial destination position, and store. Check distance to go after slewing completed, then reset DEST FIX to STORED AUTO if desired.

8. Compasses - Check. Check and synchronize FRS and check INS if applicable. Return INS mode selector switch to desired position. Check Standby Compass against runway heading.

9. Pitot heat switch - ON.

10. Warning lights - All Off.

11. External lights switch - BCN (if required).

12. Shoulder harness - Lock.

13. Flight controls - Cycle and check hydraulic pressures.

14. Suit vent boost lever - NORM.

15. [ ] power switch - ON and checked.

16. Fuel derich arming switch - ARM.

17. Elapsed time clock - Start.

TAKEOFF

1. Brakes - Hold.

2. Nosewheel steering - Engaged.

3. Throttles - Advance.

CAUTION

Engine turbine life can be appreciably decreased by too rapid throttle movement. The time for throttle advancement from IDLE to MILITARY should be no less than one second.

4. Brakes - Release at 6000 rpm.

CAUTION

The tires may skid if the brakes are held on at high thrust.

5. Engine instruments - Check at MILITARY thrust.

   a. Tachometer.

   b. Nozzle Position.

   c. Oil Pressure.

6. Throttles - Advance to afterburner midrange position after engines reach MILITARY rpm.

WARNING

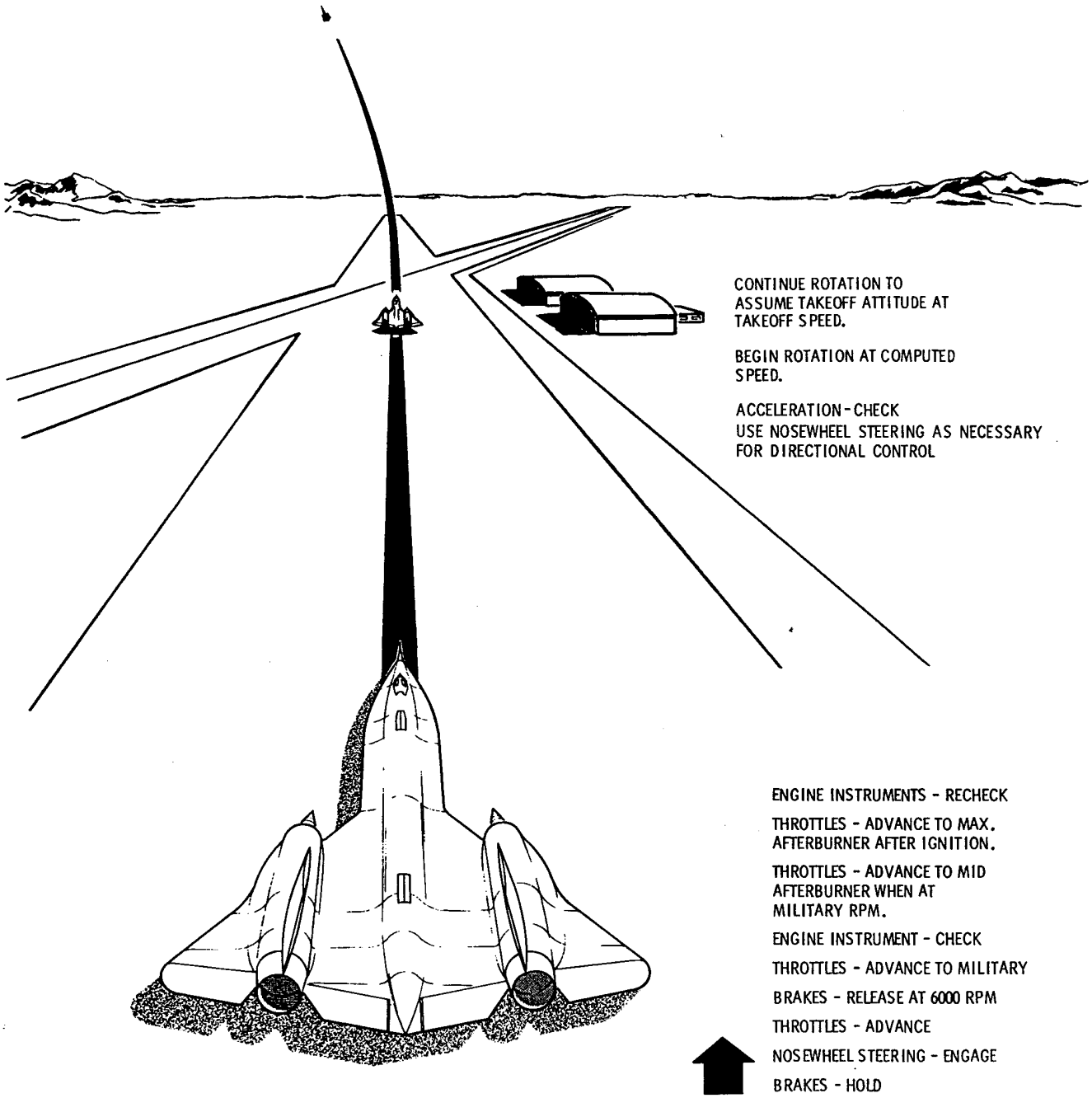
To prevent overspeed, afterburner ignition must not be accomplished before the engines reach MILITARY rpm.

TAKEOFF

NOTE

ENGINE INSTRUMENT CHECKS SHOULD BE MADE DURING THE INITIAL PORTION OF TAKEOFF ROLL.

THE TIRES MAY SKID WITH THE BRAKES ON AT HIGH ENGINE THRUST



CONTINUE ROTATION TO ASSUME TAKEOFF ATTITUDE AT TAKEOFF SPEED.

BEGIN ROTATION AT COMPUTED SPEED.

ACCELERATION - CHECK
USE NOSEWHEEL STEERING AS NECESSARY FOR DIRECTIONAL CONTROL

ENGINE INSTRUMENTS - RECHECK

THROTTLES - ADVANCE TO MAX. AFTERBURNER AFTER IGNITION.

THROTTLES - ADVANCE TO MID AFTERBURNER WHEN AT MILITARY RPM.

ENGINE INSTRUMENT - CHECK

THROTTLES - ADVANCE TO MILITARY

BRAKES - RELEASE AT 6000 RPM

THROTTLES - ADVANCE

NOSEWHEEL STEERING - ENGAGE

BRAKES - HOLD

F200-4(e)

Figure 2-3

NOTE

- Afterburner ignition should occur within 3 seconds.
- Abort the takeoff if one or both afterburners do not ignite.

Advancing the power lever to initiate afterburning results in momentary nozzle excursion, and engine transient speed oscillation may approach 250 rpm.

7. Throttles - Advance to MAXIMUM THRUST.

CAUTION

The time for throttle advancement should be no less than one second.

8. Engine instruments - Recheck at MAXIMUM THRUST.

NOTE

Exact readouts on these instruments is time consuming. The readout should be anticipated and needle position checked against a clock position. If there is any indication of improper engine performance during power advancement, the takeoff should be aborted. Monitor ground run distance and airspeed during the takeoff roll. If possible, any abort decision should be made before the aircraft has reached high groundspeed. Directional control can be maintained with nosewheel steering up to nosewheel lift off speed.

9. Acceleration - Check indicated airspeed against computed acceleration check speed at selected acceleration check distance. Refer to performance data, Appendix I, for takeoff information.

10. Rotation - Begin at computed airspeed approximately five seconds before reaching takeoff speed. Apply smooth, constant back pressure on the stick so that required stick deflection and rotation to takeoff attitude occurs at takeoff speed. Refer to Appendix I for rotation and takeoff speeds.

NOTE

Use indicated airspeed during takeoff and climb until proper climb schedule speed is reached on the triple display indicator.

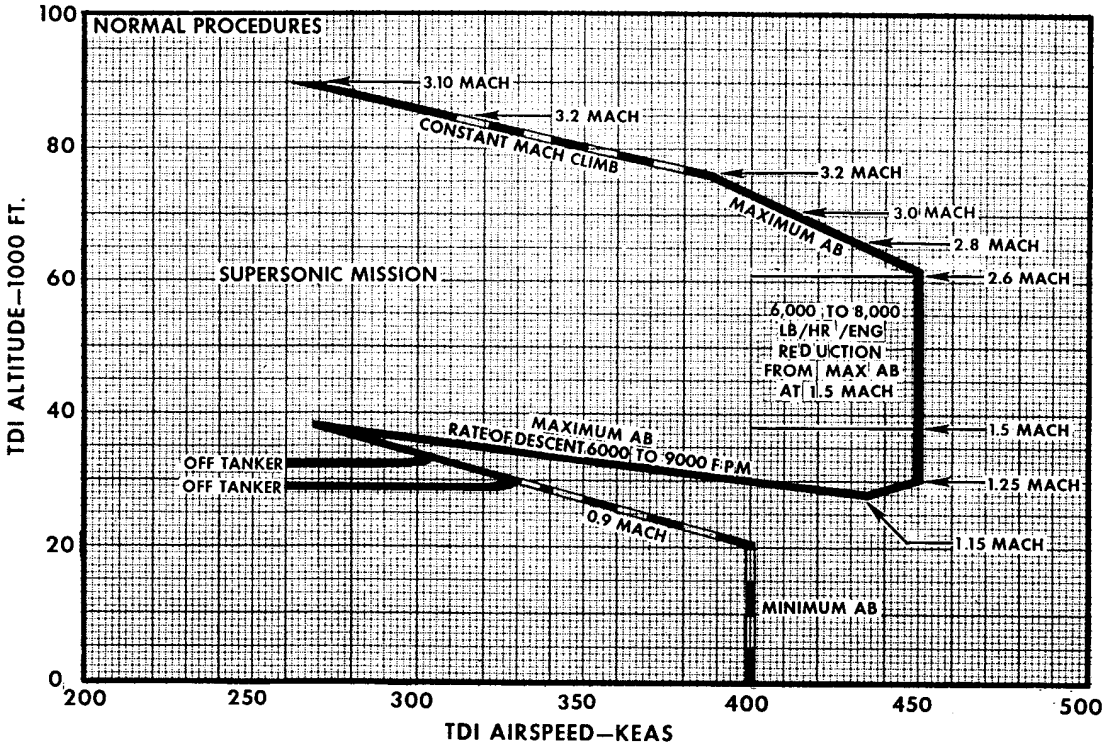
CROSSWIND TAKEOFF

During crosswind takeoffs the aircraft tends to weather vane into the wind. This will be noted when the nosewheel lifts off and nosewheel steering is no longer available. Rudder pressure must be held to counteract the crosswind effect. A definite correction must be made as the aircraft breaks ground. Apply lateral control as necessary for wings level flight. Both the directional and lateral control applications are normal and no problems should be encountered when taking off during reasonable crosswind conditions.

ROTATION TECHNIQUE

During takeoff, the maximum load on the main wheel tires occurs during rotation to takeoff attitude.

CLIMB SPEED SCHEDULES



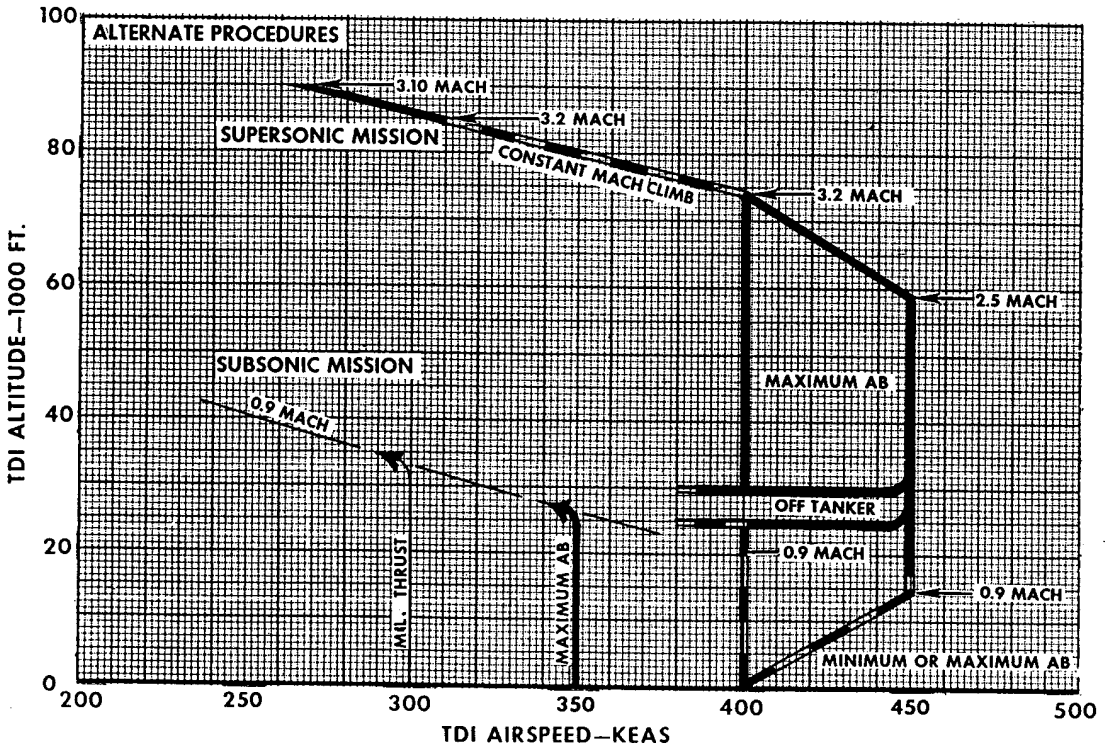


Figure 2-4

CAUTION

Avoid abrupt rotation since this can impose an excessive load on the tires and cause blowouts.

In general, the tires are more critical during takeoff than at landing because of the higher ground speeds and gross weights involved. Wing lift quickly relieves the gear load as the nose is raised. Start rotation approximately five seconds before reaching the scheduled takeoff airspeed. Premature nosewheel lift off should be avoided because the unnecessary drag extends the ground run. Delayed rotation also extends the ground run and may result in excessive tire speeds.

AFTER TAKEOFF

When definitely airborne:

1. Landing gear lever - UP.

NOTE

The gear will retract in approximately 12 seconds. Observe landing gear limit speed while gear is extended.

WARNING

Single engine operation is critical immediately after takeoff. Increasing airspeed and decreasing angle of attack has greater benefits than gaining altitude at a maximum rate.

After gear retraction is complete:

2. Throttles - Climb power.

   Minimum afterburning is normally set after takeoff. When flight plan deviates from normal climb procedure, maintain maximum afterburning or reduce power in accordance with alternate plan.

3. Engine instruments - Check.

At Mach 0.5:

4. Surface limiter release handle - Engage

   Rotate handle counterclockwise and stow to engage limiters. Check SURF LIMIT warning light off to confirm engagement.

5. Airspeed - Establish climb schedule.

   For normal operation:

   a. 400 KEAS while below FL 200.

   b. Mach 0.9 while subsonic above FL 200.

6. Altimeter - Set to 29.92" Hg at FL 180.

Above FL 200, with CIT 5° to 15°C:

7. EGT trim - Check 815° ± 25°C.

NORMAL CLIMB

The normal climb procedure optimizes power and airspeed schedules for supersoni range and is applicable to climbs after takeoff or air refueling. Use of alternate procedures is permitted, but results in degraded supersonic range capability. The general technique for airspeed and power scheduling is as follows:

a. After takeoff, accelerate to 400 KEAS in a climbing flight path, then climb with minimum afterburning at 400 KEAS. Intercept Mach 0.9 at approximately 20,000 feet and readjust climb attitude to hold 0.9 to 0.95 Mach numbe The autopilot KEAS Hold and Mach Hold

features may be used for this climb phase. Adjust throttles to maximum afterburning at approximately 32,000 feet.

b. After refueling, set maximum afterburning power and accelerate to intercept 0.9 Mach number, then climb at 0.90 to 0.95 Mach number. When the autopilot Mach Hold feature is used, engage Mach Hold at Mach 0.93.

c. At FL 380, level out momentarily, disengage the autopilot, and push over at approximately 0.8 g's. Establish a 6000 fpm to 9000 fpm rate of descent. Accelerate toward 450 KEAS. Plan this maneuver so as to avoid turns while below Mach 1.15.

NOTE

It is most important to exceed Mach 1.05 early in the descent, and to attain Mach 1.15 before starting the pull-out with sufficient airspeed margin so as not to exceed 450 KEAS.

The 37,000 ft. to 39,000 ft. maximum altitude band is optimum for a wide range of ambient temperatures when rates of descent of 6000 fpm to 9000 fpm are used. 39,000 ft. and 9000 fpm may be favored with tropic hot day temperatures. 37,000 ft. and 6000 fpm may be used with good results when ambient temperatures are below standard.

NOTE

When possible, check EGT trim before starting the transonic acceleration maneuver. Abnormally low EGT degrades performance.

d. After Mach 1.15 is attained, approximately 435 KEAS, start a smooth round-out so as not to exceed 450 KEAS. A peak load factor of up to 1-1/2 g's may be required as level attitude is approached. Climb at 450 KEAS, using the autopilot KEAS Hold feature as desired.

e. At Mach 1.5, reduce power to obtain a fuel flow reduction of 6000 to 8000 pounds per hour per engine. Maintain 450 KEAS to Mach 2.6.

f. At Mach 2.6, approximately 60,800 ft., increase power to maximum afterburning and begin decreasing airspeed 10 KEAS per 0.1 Mach increase. If engaged, the autopilot KEAS Hold feature accomplishes the speed decrease automatically.

g. As cruise Mach number and/or initial cruise altitude are approached, reduce power so as to end the climb and start cruise climb as briefed.

The following procedure is recommended after air refueling or when the after takeoff procedures are completed:

After refueling, or at FL 320 after takeoff:

1. Throttles - Maximum afterburning.

2. Airspeed - Mach 0.93.

   Mach Hold may be used if desired.

3. Cockpit and Q-bay auto temp controls - Adjust to individual settings as required.

4. HF radio and [ ] - Check as briefed.

NOTE

5. EGT trim - Check.

RPM*	6500	6400	6300	6200	6100	6000
EGT**	800	750	710	670	630	590
CIT	0	-10	-18	-27	-36	-45

* Allowable rpm vs CIT tolerance is ± 150 rpm.
** Normal EGT is in °C ± 25°C.

Use above table, or base trim check on information supplied by tanker while refueling.

At FL 380:

6. Airspeed - Start transonic acceleration to 450 KEAS.

   Disengage autopilot and establish 6000 fpm to 9000 fpm rate of descent. After Mach 1.15 attained, round-out to supersonic climb speed. Do not exceed 450 KEAS.

At Mach 1.3:

7. Oscillograph switches - ON as briefed.

At Mach 1.5:

8. Throttles - Reduce fuel flow 6000-8000 pph per engine.

At Mach 1.7:

9. Aft bypass controls - Set both to B position (50% open).

NOTE

At approximately Mach 2.3 (CIT 150° to 190°C.) there will be a slight but noticeable yaw as the compressor bypass bleeds open if the left and right engines do not operate on exactly the same schedule.

10. Pitot heat switch - OFF below FL 600.

NOTE

The PITOT HEAT warning light will illuminate if pitot heat is left on above FL 600 while climbing.

11. IFF/SIF controls - As briefed at FL 600.

12. Beacon and fuselage lights - Off above FL 600.

At Mach 2.6:

13. Throttles - Maximum afterburning.

14. KEAS - Checked.

    Decrease KEAS 10 knots per 0.1 Mach number increase in speed above Mach 2.6. The KEAS Hold function of the autopilot should maintain this schedule automatically if engaged.

Mach No.	2.6	2.7	2.8	2.9	3.0	3.1	3.2
KEAS	450	440	430	420	410	400	390

At Mach 2.7:

15. Aft bypass controls - Set both to A position (15% open).

At Mach 3.0:

16. Aft bypass controls - Set both to CLOSED position.

Reduce equivalent airspeeds if climb is to be continued after reaching the desired Mach number.

Desired supersonic speeds may be maintained by throttling to partial afterburning settings. Maintain EGT by use of trim switches.

17. Oscillograph switches - OFF or as briefed.

ALTERNATE CLIMB

Deviations from Normal Climb procedures are permitted when limitations of Section V are observed. Maximum Thrust may be used continuously, but fuel economy will be less than for normal climb procedures. See figure 2-4. The recommended Military Thrust climb speed is a constant 300 KEAS. EGT can be expected to decrease as CIT decreases. The recommended Maximum Thrust climb speed for subsonic operation is 350 KEAS to approximately FL 260, and Mach 0.9 above that altitude. When Maximum Thrust is used continuously after takeoff, a definite rotation is required to establish initial climb attitude. Begin rotation sufficiently in advance of reaching the climb speed schedule to avoid overshoot. Refer to Appendix I for climb performance.

TRANSONIC OPERATION

Transonic accelerations can be started by using the 450 KEAS climb speed schedule, starting at approximately 15,000 feet, or by making a level transonic acceleration at an altitude between 25,000 and 30,000 feet.

Climbing Acceleration Procedure

When this procedure is used, accelerate from takeoff to 350 - 370 KEAS and rotate to climb attitude.

NOTE

Begin the rotation sufficiently in advance of reaching climb speed to avoid exceeding 400 KEAS. If rotation is delayed, it is possible to overshoot the airspeed by an appreciable amount.

Establish 450 KEAS at approximately 15,000 feet and climb at this speed using maximum afterburning thrust. Mach number will increase with altitude and Mach 1.0 will be reached at 20,000 feet.

CRUISE

Observe limitations of Section V.

Center of gravity control is important for optimum cruise performance. Fuel load distribution and automatic tank sequencing provides a forward cg for takeoff and initial climb. During supersonic climb and cruise, automatic sequencing provides an aft cg to minimize elevon deflection and resulting trim drag. Supplemental manual control of fuel usage is also possible, but should only be used in the event of malfunction of the automatic sequencing system.

CAUTION

Spike and forward bypass knobs must be in AUTO position when cruising above 80,000 feet.

For long range operation, establish a throttle setting for the applicable cruise KEAS/altitude weight schedule; then only make minor adjustments as necessary to maintain the schedule.

ENGINE OPERATION

Exhaust gas temperature and engine speed limits vary with CIT. Refer to Engine Operating Limits, Section V, for limit schedule.

CAUTION

As Mach number is increased, caution is required in the rate of throttle movement following afterburner ignition and during afterburner shutdown.

Oil Pressure and Temperature

Oil pressure should be monitored closely. Mach number should be reduced if pressure does not remain within the limits listed in Section V or if the oil temperature warning light illuminates.

PRIOR TO DESCENT

Retrimming of EGT should not be required prior to start of descent unless manual uptrimming has been accomplished during climb or cruise. The amount of downtrim required will be approximately equal to the total prior uptrim. Pilot judgement must govern its use. As a general rule, 755°C EGT at start of deceleration should prevent overtemperature conditions and provide normal engine operation at lower Mach numbers. Retrim if necessary and accomplish the following before descending in order to obtain scheduled descent distance.

1. Throttles - Slowly retard to minimum afterburning position.
2. Spike knobs - Check AUTO.
3. Inlet air aft bypass switches - Check normal schedule.
4. Inlet air forward bypass knobs - Check AUTO.

DESCENT

Aircraft deceleration rates are limited by maximum tolerable temperature transients within the engines. Engine cooling rates will be satisfactory when deceleration rate is not greater than prescribed in Section V. Use of Military Thrust and a speed schedule of 300 KEAS during deceleration to Mach 2.5 satisfies this requirement when the spikes are set in AUTO. Descents can be made at engine speeds below the Military rpm schedule between Mach 2.5 and Mach 1.0. Throttles may be set as desired at subsonic speeds.

WARNING

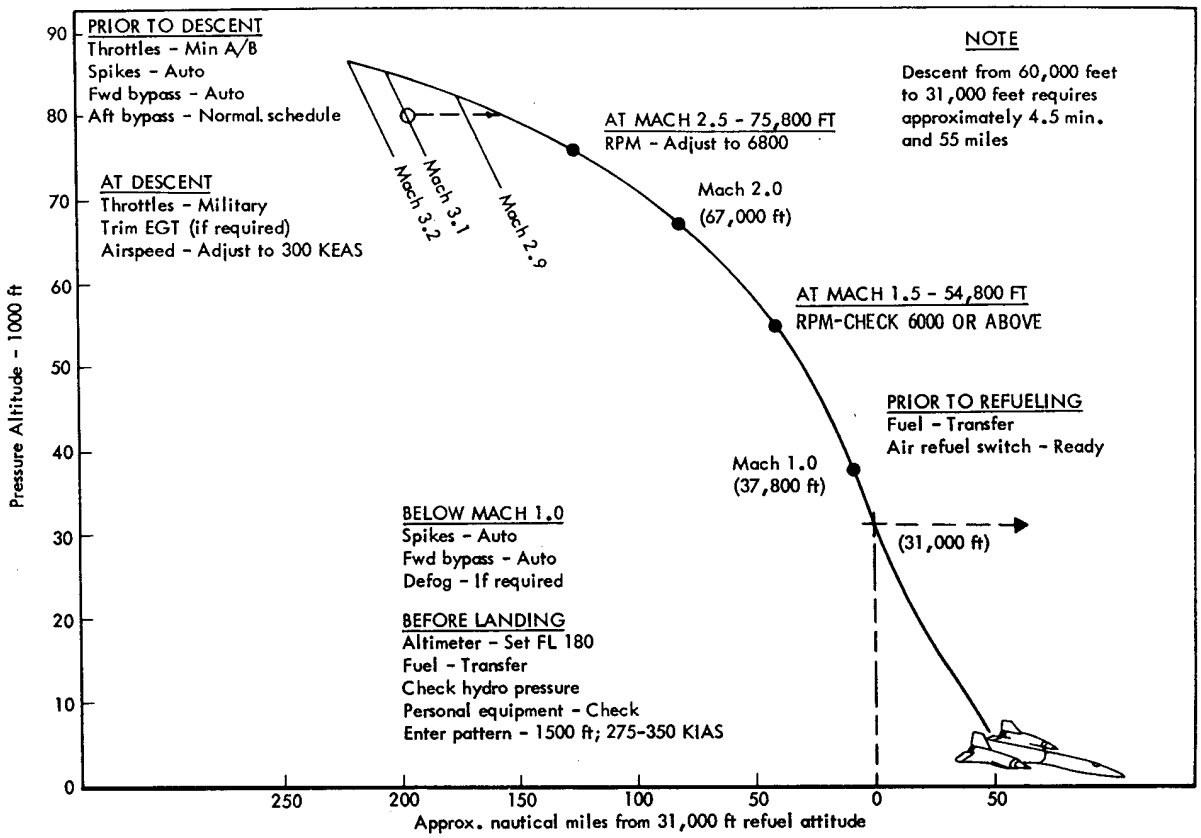
Monitor fuel tank pressure during descent, and reduce rate of descent if necessary in order to maintain positive fuel tank pressure.

A high descent rate below FL 500 can exceed the LN_2 system ability to pressurize the fuel tanks. Negative pressure allows atmospheric oxygen to enter the tanks through the vacuum relief valve. If fuel vapor temperature in the tanks is high, above approximately 410°F (or 210°C), and tank internal pressure is equivalent to 30,000 feet pressure altitude, or less, mixture with a critical percentage of oxygen can result in fuel vapor ignition.

NORMAL DESCENTS

In the event of inlet roughness set the forward bypass doors open, then set the spikes forward and increase rpm if necessary. Refer to appendix for normal descent performance, and for performance with forward bypass open.

DESCENT PROFILE



300 KEAS NORMAL DESCENT SCHEDULE TABLE

Press. Alt. - 1000 ft.	MACH NUMBER											
	3.20	3.10	3.00	2.90	2.80	2.70	2.60	2.50	2.0	1.50	1.20	0.90
	DTG and (KEAS) are at start of decel.											
86.3	241 (300)											
85.0	239 (310)	225 (300)										
83.6	236 (321)	222 (311)	209 (300)									
82.1	233 (332)	220 (321)	206 (311)	195 (300)								
80.6	230 (344)	217 (333)	204 (323)	192 (312)	181 (300)							
79	228 (357)	214 (346)	200 (334)	189 (323)	178 (312)	169 (300)						
77.4	225 (371)	211 (359)	198 (347)	186 (336)	175 (324)	166 (312)	158 (300)					
75.9	222 (384)	209 (372)	195 (360)	183 (348)	172 (336)	163 (324)	156 (312)	147 (300)				
66.8									101 (300)			
54.7										60 (300)		
45.3											41 (300)	
33.4												23 (300)

Notes: Altitudes given in 1000 feet.
Distances to go - DTG - are n. mi.
Inlet - Spikes, AUTO
Fwd bypass doors, AUTO
Aft bypass doors, Normal schedule
No turns.
Military thrust above Mach 2.5
20 mi. tanker overtake allowance included.
Make additional 20 mi. allowance for straight in approach to pattern altitude.

F200-76(b)

Figure 2-5

1. Throttles - MILITARY.

At Mach 3.0:

2. Aft bypass switches - Position A.

3. EGT trim - Down trim if required.

4. Airspeed - Adjust to 300 KEAS. Maintain cruise altitude until 300 KEAS is intercepted. Rate of deceleration must not exceed allowable Mach rate.

5. Fuel tank pressure - Check.

At Mach 2.7:

6. Aft bypass switches - Position B.

At Mach 2.5:

7. Throttles - Adjust to 6800 rpm. Maintain at least 6500 rpm while above Mach 2.0.

NOTE

Set forward bypass open, spikes forward and increase rpm as required if inlet roughness is encountered.

8. IFF/SIF controls - As briefed at FL 600.

9. INS mode switch - FRS.

10. Pitot heat switch - ON.

NOTE

The PITOT HEAT warning light will illuminate if pitot heat is left off below FL 500 while descending.

11. External lights switch - As desired.

At Mach 1.7:

12. Aft bypass switches - CLOSED.

At Mach 1.5:

13. RPM - Check 6000 or above.

    Maintain at least 5500 during remainder of descent to subsonic speed.

Below Mach 1.0:

14. Throttles - Adjust as required. Rate of descent must not result in negative fuel tank pressure. Avoid speed below 5100 rpm to prevent cycling of engine start bleed valves.

15. Airspeed - Adjust as desired.

16. Forward bypass - Check closed indication.

17. Defog switch - ON and HOLD if required.

At FL 180:

18. Altimeter - Set.

19. Use pitot static system for descent.

AIR REFUELING PROCEDURES

Either of two methods of handling power during refueling may be used. Whenever the initial fuel quantity remaining is over approximately 15,000 pounds it is possible to use minimum afterburning on one engine and less than Military thrust on the other. This allows refueling to be accomplished at a constant altitude of approximately 32,000 feet, using the non-afterburning engine for thrust control. Normally or when at light weight, the initial contact should be made using non-afterburning power settings. One afterburner should then be lighted after temporarily disconnecting when the aircraft

AIR REFUELING DIRECTOR LIGHTS

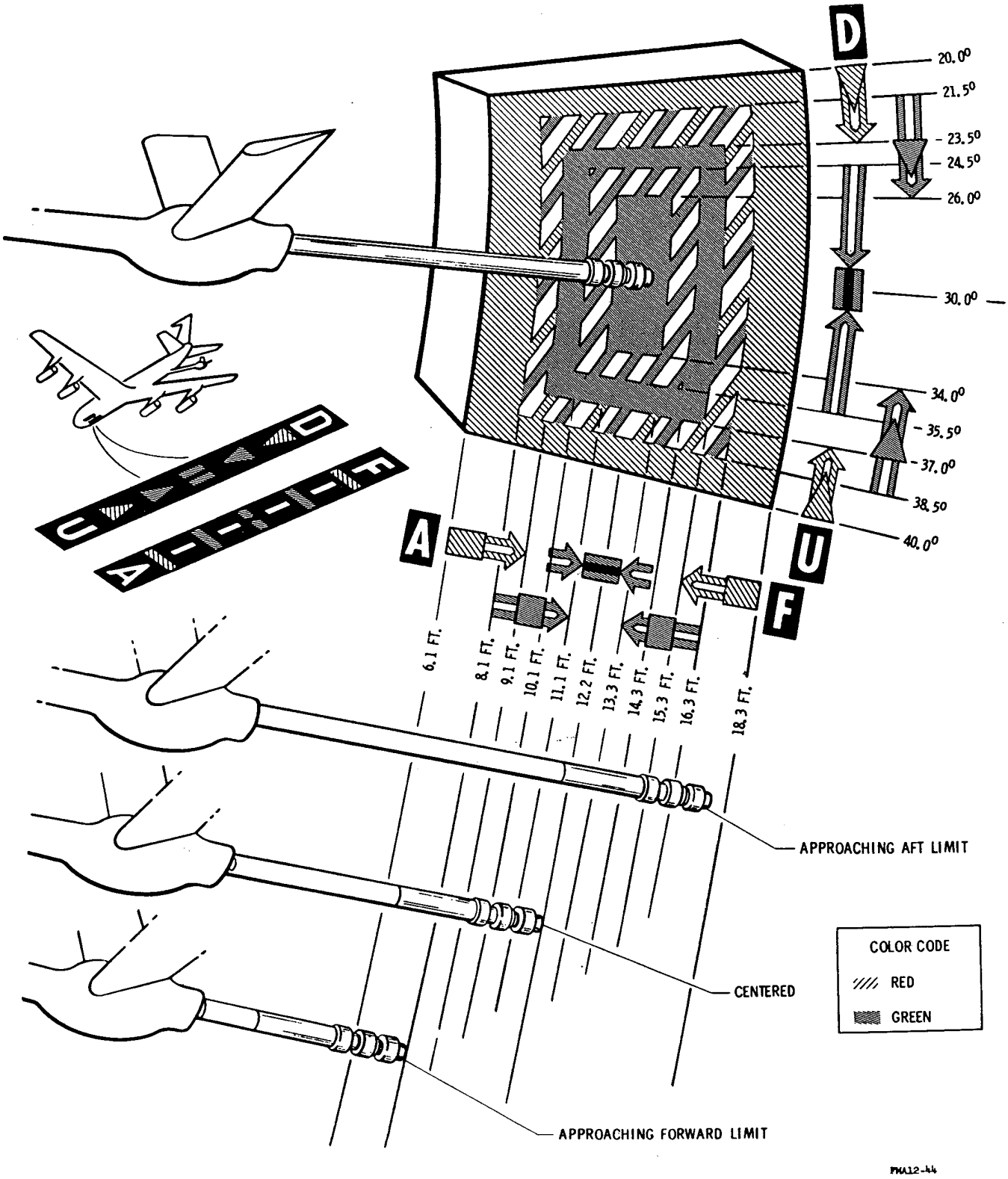
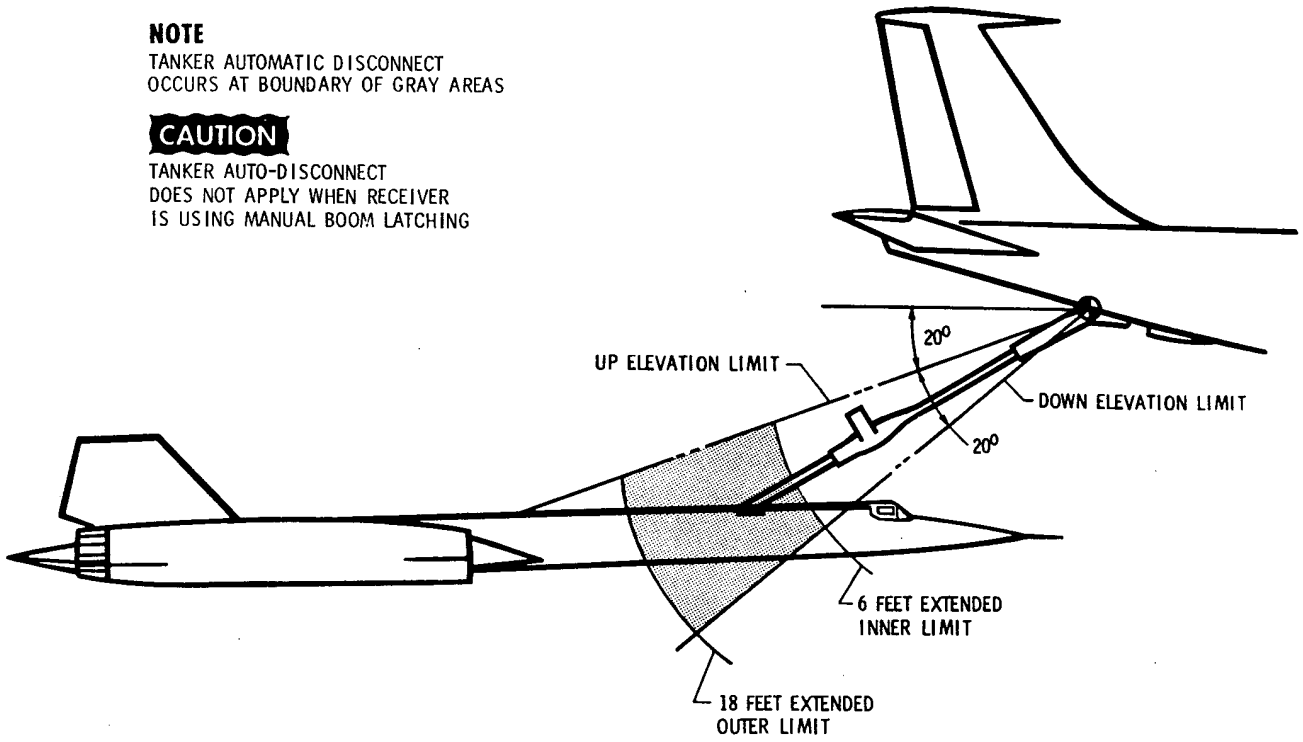


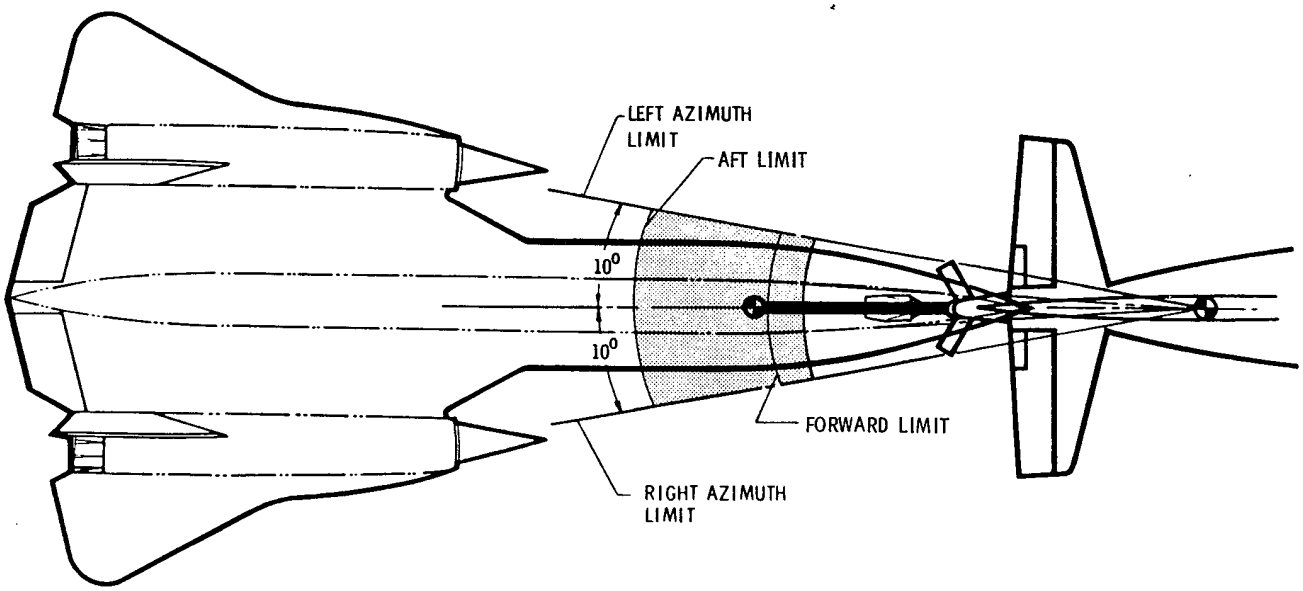
Figure 2-6

AIR REFUELING BOOM ENVELOPE

NOTE
TANKER AUTOMATIC DISCONNECT
OCCURS AT BOUNDARY OF GRAY AREAS

CAUTION
TANKER AUTO-DISCONNECT
DOES NOT APPLY WHEN RECEIVER
IS USING MANUAL BOOM LATCHING





F200-6(a)

Figure 2-7

becomes power limited at Military thrust. The conventional procedure of completing refueling without use of an afterburner can also be used; however, a toboggan to approximately 25,000 feet will be necessary after the tanks are filled to 1/2 to 2/3 capacity.

Prior to air refueling, stabilize and trim at refueling speed for contact. Observe the tanker for director light signals and a maneuver as directed by the lights. A successful connection is confirmed by a mild jolt to the aircraft, steady illumination of the director light panel and the extinguishing of the READY light. Slight maneuvering may be necessary at this point to illuminate the azimuth and elevation neutral lights during fuel transfer. Contact can be maintained between the aircraft and tanker during a turn or in a descent. No adverse flight characteristics are present due to tanker downwash. After the disconnect occurs, separation is made down and to the rear of the tanker.

PRIOR TO REFUELING

Accomplish the following prior to refueling:

1. Radar beacon - As briefed.
2. Air refuel switch - READY.

NOTE

Amplifier requires up to approximately five minutes for warmup.

3. Forward transfer switch - TRANS (Transfer 2000-4000 lbs).

CAUTION

If less than a full fuel load is onloaded, it is possible for an abnormal aft c.g. to develop.

4. Fuel quantity indicator selector - TOTAL. Monitor total fuel quantity.
5. Seat - Lower.

When in observation position after rendezvous with tanker.

6. UHF radio INT-EXT mode switch - INT.
7. READY light - Push on (green) if necessary.
8. Forward transfer switch - OFF.
9. Stabilize in pre-contact position.
10. Beacon light switch - FUS.
11. Observe tanker director lights illuminated and boom in ready for contact position.

NORMAL REFUELING

Normal refueling is accomplished as follows:

1. Establish contact.

After contact is made:

2. READY light - Check out.
3. Total fuel quantity - Monitor.

When refueling is complete:

4. Control stick disconnect - Press.
5. Air refuel switch - OFF. Check ready light off.
6. Tanks 1, 2, 6 - Check ON.
7. Trim engines to EGT supplied by tanker.
8. Radar beacon - OFF.

In case L hydraulic pressure is lost, R pressure may be utilized for refueling by moving the brake switch to ALT STEER & BRAKE position.

CAUTION

Do not leave the brake switch in the ALT STEER & BRAKE position after refueling.

ALTERNATE REFUELING PROCEDURE

The boom may be latched in the refueling receptacle manually as an alternate procedure by using the following procedure:

1. Air refuel switch - MANUAL. Check READY light on.

2. Control stick disconnect - Press and hold.

When nozzle has bottomed in the receptacle:

3. Control stick disconnect - Release.

CAUTION

If the disconnect trigger is released before the nozzle is in the bottom of the receptacle, it is possible for the nozzle to damage nozzle latches, preventing any further refueling.

4. Fuel quantity - Monitor TOTAL fuel.

When refueling is complete:

5. Control stick disconnect - Press.

CAUTION

The automatic limit disconnect system is inoperative. All disconnects must be initiated by the receiver aircraft, since the tanker operator is unable to release the nozzle latches during manual boom latching.

6. Accomplish steps 5, 6, 7, 8 of Normal Procedure.

NOTE

If a malfunction occurs which prevents disconnecting the boom, place the Air Refuel switch in the MANUAL position and depress the IFR DISC trigger. If disconnect is not accomplished proceed with brute force pullout by retarding throttles.

BEFORE LANDING

Below 20,000 feet:

1. Cockpit and Q-bay auto temp controls - Adjust to approximately two-o'clock position or as required to avoid cockpit fog.

CAUTION

- Monitor Q-bay and cockpit temperatures to avoid equipment overheat, if possible.

- Keep UHF radio transmissions to a 5 second maximum if possible while defogging step is employed.

2. Fuel transfer switch - FWD TRANS, if required.

NOTE

When tank 5 or 6 contains fuel, transfer 1000 to 4000 lbs forward to obtain a slight nose up pitch trim.

3. Surface limiter handle - Pull out and rotate 90° CW at Mach 0.5.

4. Periscope MIR SEL handle - Full forward.

LANDING PATTERN (Typical)

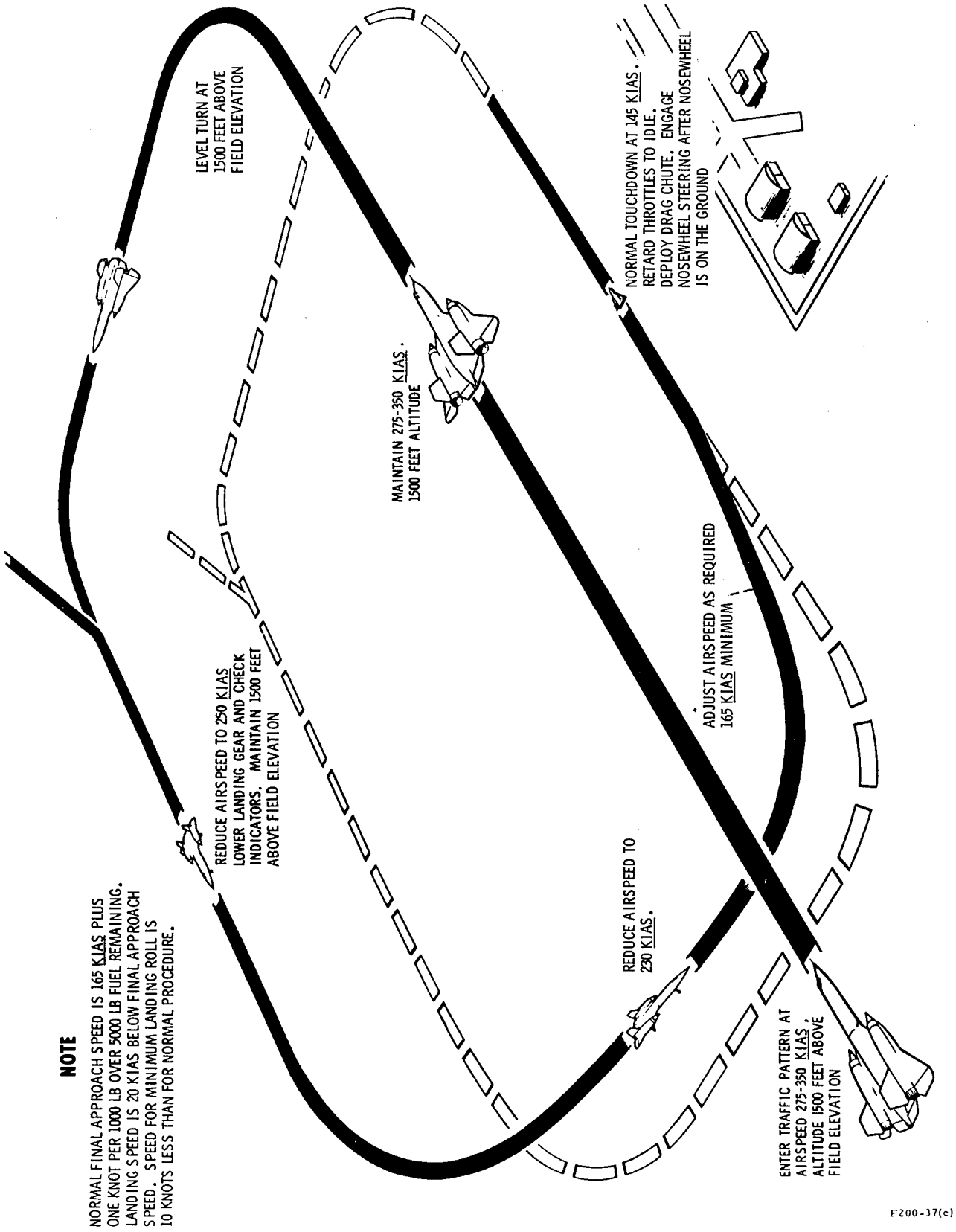

LEVEL TURN AT 1500 FEET ABOVE FIELD ELEVATION
MAINTAIN 275-350 KIAS. 1500 FEET ALTITUDE
NORMAL TOUCHDOWN AT 145 KIAS. RETARD THROTTLES TO IDLE. DEPLOY DRAG CHUTE. ENGAGE NOSEWHEEL STEERING AFTER NOSEWHEEL IS ON THE GROUND
REDUCE AIRSPEED TO 250 KIAS LOWER LANDING GEAR AND CHECK INDICATORS. MAINTAIN 1500 FEET ABOVE FIELD ELEVATION
ADJUST AIRSPEED AS REQUIRED 165 KIAS MINIMUM
REDUCE AIRSPEED TO 230 KIAS.
ENTER TRAFFIC PATTERN AT AIRSPEED 275-350 KIAS, ALTITUDE 1500 FEET ABOVE FIELD ELEVATION
NOTE
NORMAL FINAL APPROACH SPEED IS 165 KIAS PLUS ONE KNOT PER 1000 LB OVER 5000 LB FUEL REMAINING. LANDING SPEED IS 20 KIAS BELOW FINAL APPROACH SPEED. SPEED FOR MINIMUM LANDING ROLL IS 10 KNOTS LESS THAN FOR NORMAL PROCEDURE.
F200-37(e)

Figure 2-8

5. Hydraulic pressures - Check.

6. Fuel transfer switch - OFF.

7. [ ]power switch - OFF.

8. Shoulder harness - Manually locked.

9. Face plate - Open.

10. Oxygen - OFF.

11. Traffic pattern entry - 275 to 350 KIAS, 1500 feet above field elevation.

12. Downwind - 250 KIAS, 1500 feet above field elevation.

13. Landing gear lever - DOWN (check gear down and locked).

NOTE

Normal gear extension time is approximately 16 seconds. Observe gear limit speed with gear extended.

14. Base leg - 220 to 230 KIAS.

15. Final approach - Maintain 165 KIAS minimum with 5000 pounds of fuel.

NOTE

Base minimum final approach speed on intended touchdown speed. Do not use maximum performance final approach speed unless operating conditions require minimum roll or runway is wet or icy.

See figure 2-8 for a typical landing pattern.

16. Landing and taxi lights switch - As required.

LANDING

NORMAL LANDING

Refer to the Appendix for landing ground roll distances. If airspeed becomes excessively low, a high sink rate will develop resulting in a hard landing. During the flare, throttles are reduced to IDLE and touchdown is made at approximately 10° pitch angle (nose approximately on the horizon).

The following procedures should be employed:

1. Throttles - IDLE.

CAUTION

Throttle movement should follow quadrant curvature so that the hidden ledge at the IDLE position can prevent inadvertent engine cutoff.

2. Touchdown speed - As required.

3. Hold nosewheel off.

CAUTION

Fuselage angle must not exceed 14° to avoid scraping the tail.

4. Drag chute handle - Pull to deploy. Chute deployment takes approximately three seconds.

5. Lower nosewheel at 110 KIAS.

6. Engage nosewheel steering for directional control. Steering will not engage until rudder pedals align with nosewheel position (straight ahead) and weight of aircraft is on any one gear.

7. Brakes - Apply after chute deployment. Moderate braking may be used prior to chute deployment.

CAUTION

If the chute does not deploy observe the brake energy limit speeds in Section V. Brake switch should remain in the ANTI-SKID position if runway is dry. Refer to Drag Chute Failure, Section III.

8. Drag chute handle - Turn and push to jettison chute.

CAUTION

The drag chute should be jettisoned while the aircraft still has forward motion to prevent drag chute collapse. The aircraft should not be taxiied with a collapsed drag chute.

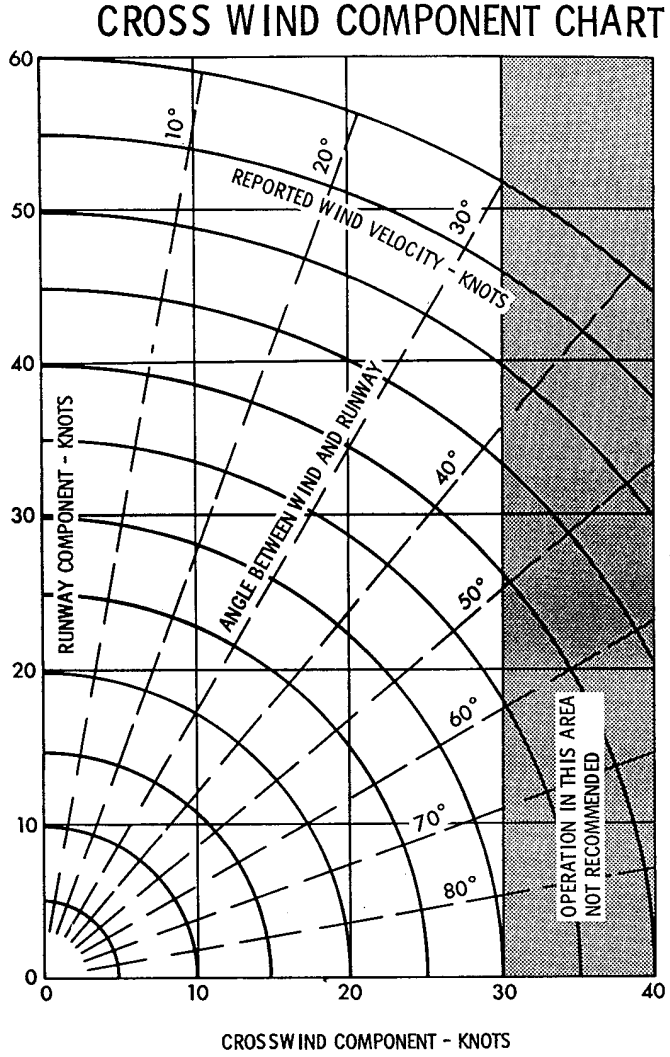


Figure 2-9

CROSSWIND LANDING

The traffic pattern for a crosswind landing should be normal, making proper allowances for velocity and direction of the cross wind. Proper runway alignment on final approach can be maintained by crabbing or dropping one wing; however, a combination of the two is recommended just prior to flare. Remove crab before touchdown, using wing low technique to prevent side drift. Reduce sink rate to a minimum to accomplish smooth touchdown. At increased cross wind components, sink rate must be minimized due to increase of side loads imposed on the landing gear. With more than a 30 knot crosswind component it may be advisable to lower the nose and engage

nosewheel steering prior to drag chute deployment. With less than 30 knot crosswind component, rudder control is sufficient to offset the crosswind effect on the drag chute.

LANDING ON SLIPPERY RUNWAYS

Wet Runway

Set brake switch NORMAL and, when field length would be critical in the event of drag chute failure, use minimum roll technique. Landing roll will increase due to reduction in available braking force. Use lightest brake pressure consistent with stop distance available.

WARNING

Tests indicate that the aircraft will plane with heavy water conditions on the runway. With this condition, directional control in a crosswind may be difficult.

Icy Runways

Same as wet runway except braking effectiveness is further reduced.

MINIMUM ROLL LANDING

a. Make touchdown close to the end of the runway at minimum airspeed. This is primary for a successful short field landing.

b. Deploy the drag chute as quickly as possible after touchdown. Lower the nosewheel while the chute is deploying.

c. Apply maximum braking immediately after chute deployment. Moderate braking may be used prior to chute deployment.

d. Throttles to IDLE during flare or immediately after touchdown.

e. Right engine throttle OFF after touchdown.

NOTE

Retarding both throttles to OFF further reduces thrust, but eliminates nosewheel steering and braking. If the brakes are burned out at the end of the runway, and speed will permit a safe turn off, the nosewheel steering system will "save" the landing.

Throttle technique depends upon the pilot's judgement of the particular field conditions.

WARNING

Engine shut down will result in loss of hydraulic actuating pressure for the following systems:

a. Right engine shutdown - Alternate brakes and NWS system.

b. Left engine shutdown - Normal and anti-skid brakes.

GO-AROUND

A go-around may be initiated anytime during the approach, or during landing roll when sufficient runway remains for takeoff.

GO-AROUND (Typical)

NOTE

The excess thrust available to perform a go-around varies with airspeed, gross weight, airplane configuration, field elevation and ambient temperature. As extremes of these variables are approached, the ability to perform a successful go-around with military thrust decreases, thus requiring afterburning thrust. Refer to appendix for charts showing variation in performance to be expected with changes in these operating conditions.

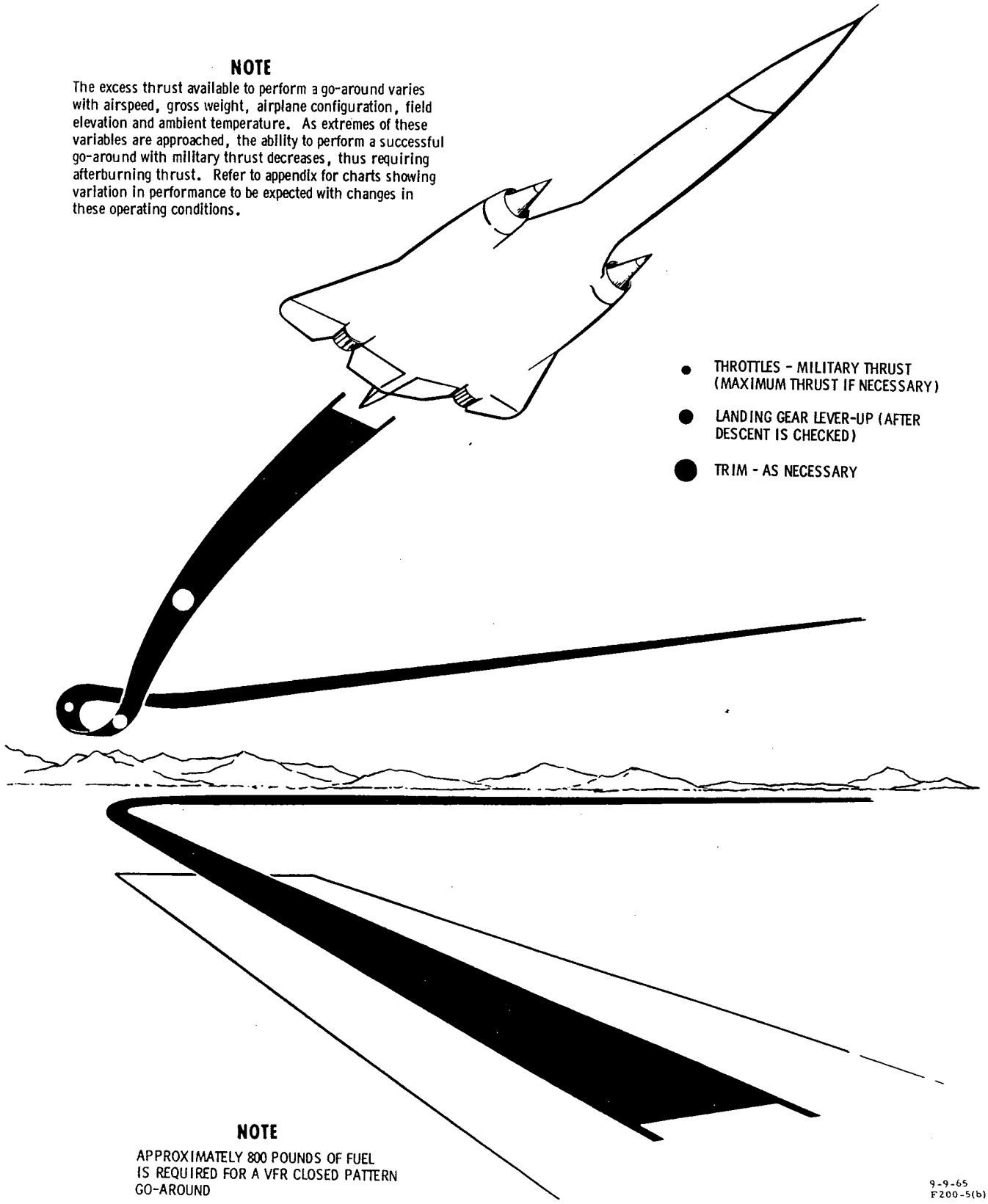

THROTTLES - MILITARY THRUST (MAXIMUM THRUST IF NECESSARY)
LANDING GEAR LEVER-UP (AFTER DESCENT IS CHECKED)
TRIM - AS NECESSARY
NOTE
APPROXIMATELY 800 POUNDS OF FUEL IS REQUIRED FOR A VFR CLOSED PATTERN GO-AROUND
9-9-65
F200-5(b)

Figure 2-10

1. Drag chute handle - Turn and push to jettison chute, if deployed.

2. Throttles - MILITARY thrust, MAXIMUM thrust if required.

3. Landing gear lever - UP after positive climb established.

4. Trim - As necessary.

AFTER LANDING

1. Pitot heat - OFF.

2. SAS channel switches- OFF (before taxiing).

3. Lighting switches - As required.

4. Suit vent boost lever - Set at 2/3.

5. Adjust cockpit and Q-Bay temperature control for comfort and equipment cooling.

CAUTION

If taxiing with the canopy open is desired, the canopy should be opened only when the aircraft is completely stopped and canopy seal pressure is off. It should only be opened if both engines and both air conditioning systems are operating normally and after the normal cockpit post-flight check of INS and Q-bay and associated equipment has been accomplished and this equipment turned off. The maximum taxi speed with the canopy open and latched is 40 knots. Gusts or severe wind conditions should be considered as a portion of the limit taxi speed.

ENGINE SHUTDOWN

CAUTION

The engine should be operated at IDLE for 5 minutes (including taxi time) before engine shutdown to permit uniform turbine cooling and prevent possible rotor seizure.

1. Wheel chocks - Installed.

2. Canopy seal pressure lever - OFF.

3. Canopy - Open.

4. INS - As briefed.

CAUTION

The INS should not be operated more than 5 minutes after opening the canopy to avoid the possibility of excessive INS component temperatures.

NOTE

In the event of engine fire during shutdown, the engine can be motored with fuel OFF to blow out fire if starter unit is connected. Refer to Section III.

5. Igniter purge switch - DUMP. Hold 30 seconds.

6. Recorders - OFF.

7. External power - Connect, if available.

8. Battery switch - EXT PWR or OFF as required.

9. Generator switch - TRIP (momentary).

10. Appropriate electrical switches - OFF.

11. Throttles - OFF.

12. Seat and canopy pins - Installed.

STRANGE FIELD PROCEDURES - AS BRIEFED.

ABBREVIATED CHECKLIST

Normal and emergency procedures abbreviated checklists are furnished separately.

EMERGENCY PROCEDURES

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INTRODUCTION

This section provides recommended procedures for use in the event of emergency or abnormal operating conditions. It does not cover multiple emergencies. Pilots must recognize that single malfunctions will often affect operation of other aircraft systems and require corrective actions in addition to those contained in a specific emergency procedure.

Use of Checklists

Critical emergency checklist items are those actions which must be performed immediately if an emergency is not to be aggravated. These steps appear in CAPITAL letters to permit immediate identification. They must be committed to memory to permit accomplishment without reference to the Abbreviated Checklist.

Definitions of Landing Situations

The terms "land when practicable" and "land as soon as possible" are not used interchangeably. The direction to "land when practicable" means to land at home base or other suitable alternate. Air refueling is allowed when necessary in order to reach the suitable destination. Alteration of the original flight plan may or may not be required, depending on the flight limits which are imposed because of the emergency or abnormal operating situation.

The direction to "land as soon as possible" means land at the nearest suitable facility.

GROUND OPERATION

ENGINE FIRE

ENGINE FIRE DURING GROUND START

If there is evidence of fire during ground start, attempt to keep the engine rotating until the fire is out. Apply chemicals from outside the engine only as a last resort.

If a fire is evident during a start, or on notification:

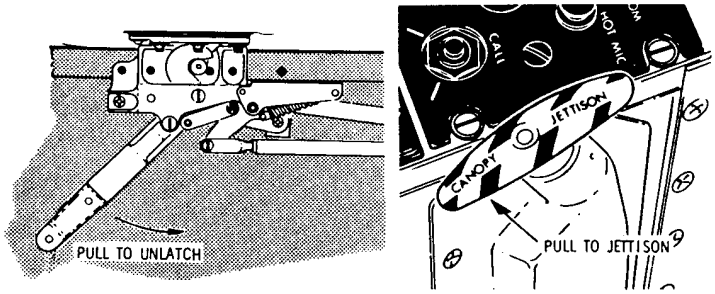
1. THROTTLE - OFF.
2. CONTINUE CRANKING ENGINE.

NOTE

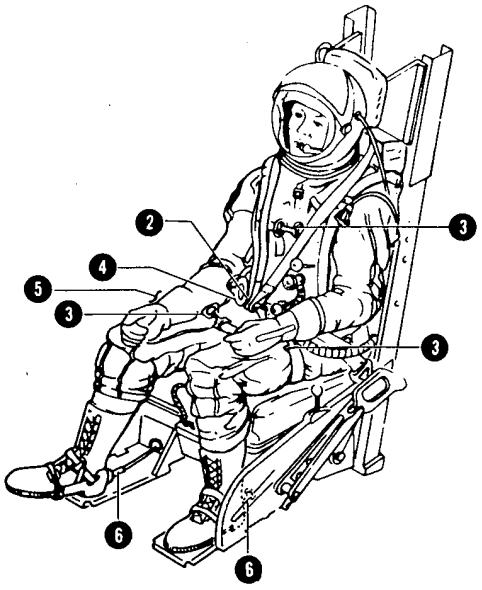
Continue motoring the engine when the starter remains engaged and fire is contained in the tailpipe. If the starter unit has disengaged, it can not be re-engaged until the engine has come to a complete stop.

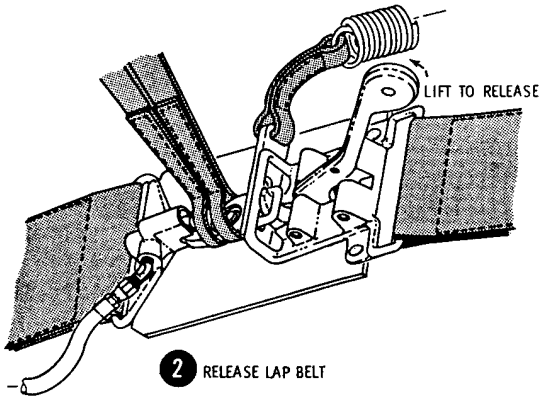
3. EMERGENCY FUEL SHUTOFF SWITCH - FUEL OFF.
4. Battery switch - OFF.
5. Abandon aircraft.

EMERGENCY OVER THE SIDE EGRESS

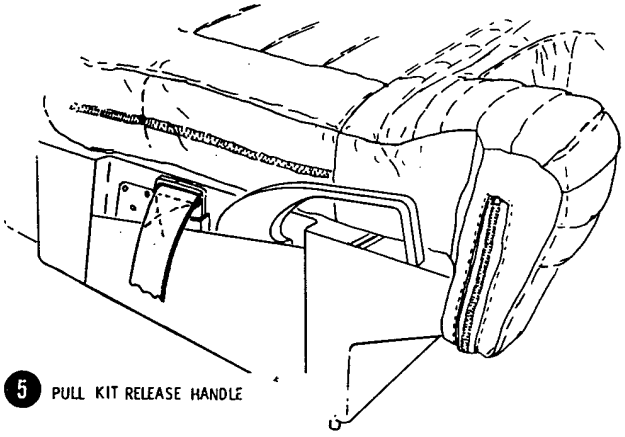


1 UNLATCH OR JETTISON CANOPY

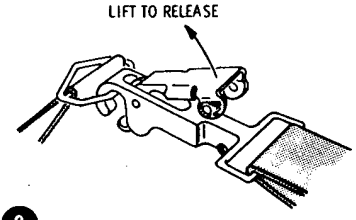




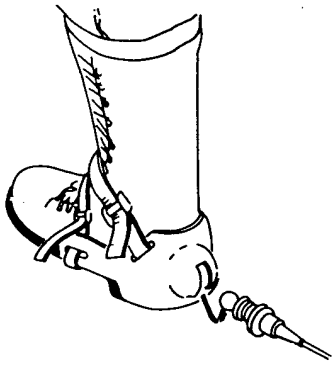
2 RELEASE LAP BELT



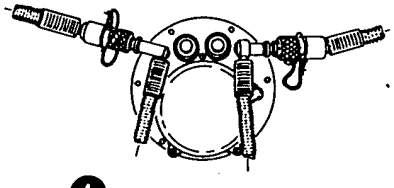
5 PULL KIT RELEASE HANDLE



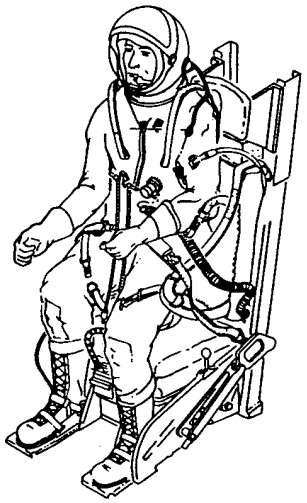
3 RELEASE PARACHUTE (3 PLACES)



6 UNLATCH SPURS (OR PULL D-RING ON HEADREST)



4 UNCLIP AND RELEASE EMERGENCY OXYGEN HOSES



7 STAND UP TO RELEASE LEADS TO HEADSET SUIT VENT CONNECTOR AND OXYGEN HOSES

F200-98(2)

Figure 3-1

ENGINE FIRE AFTER SHUTDOWN

Use applicable steps of Engine Fire During Ground Start procedure.

ABANDONING THE AIRCRAFT ON THE GROUND

In an emergency requiring ground abandonment, the primary concern is to leave the immediate area of the aircraft as soon as possible. The following procedures should be used when fire or explosion are probable. Salvaging emergency and survival equipment has not been considered. These procedures provide the fastest means of abandoning the aircraft and they should be accomplished as rapidly as possible after the decision to abandon the aircraft is made.

This procedure may be initiated while the aircraft is in motion; however, the lap belt should remain fastened until the aircraft is stopped.

To accomplish an emergency exit on the ground, proceed as follows:

1. Ejection seat safety pin - Install if time permits.
2. Survival kit release handle - Pull.
3. Seat belt and shoulder harness - Release.
4. Personal leads - Disconnect.
5. Parachute harness attachments - Release.
6. Foot spurs - Manually release, (use cable cutter if otherwise unable to release spurs).
7. Canopy - Unlatch or jettison as applicable.
8. Evacuate aircraft.

BRAKE, STEERING, OR TIRE FAILURE

Without anti-skid operating, extreme caution must be utilized to prevent wheel skid, as skidding is hard to detect due to aircraft size and weight. Tires may fail before a skid condition can be recognized and corrected. A main landing gear tire blow-out may be sensed by the pilot as a thump or muffled explosive sound.

If the ANTI-SKID OUT warning light illuminates or anti-skid braking is not effective:

1. Brake switch - ANTI-SKID OFF.

If normal brakes and/or nosewheel steering are not effective, or if L system hydraulic pressure is not available:

2. Brake switch - ALT STEER AND BRAKE.

NOTE

If both engines are shut down with the aircraft moving, the brake switch should be left in the ANTI-SKID OFF position and steady brake pressure applied to a complete stop. The brakes should not be pumped, as accumulator pressure would be lost.

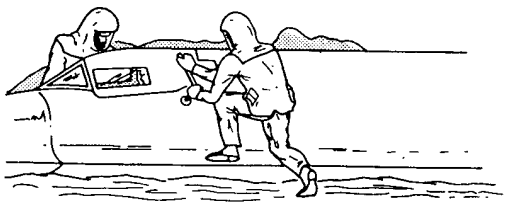
At landing weights, the aircraft can be taxied safely so long as one tire per main gear remains inflated. At takeoff weights, taxi distance should be minimized if one or two tires per main gear are flat in order to minimize the probability of further tire failures. Taxiing as necessary is permitted to clear a runway with all tires failed on a main gear, as the massive tire bead tends to protect the wheels for some distance.

EMERGENCY ENTRANCE

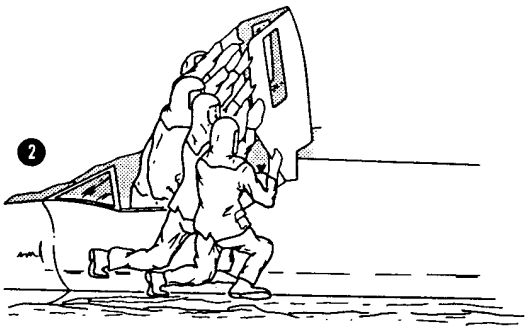
In the event that qualified ground personnel are not available, emergency entrance to the aircraft can be accomplished using the procedures illustrated by figure 3-2.

CRASH RESCUE PROCEDURES

1. INSERT TOOL INTO ONE-HALF INCH SQUARE DRIVE OPENING AND ROTATE CLOCKWISE TO OPEN

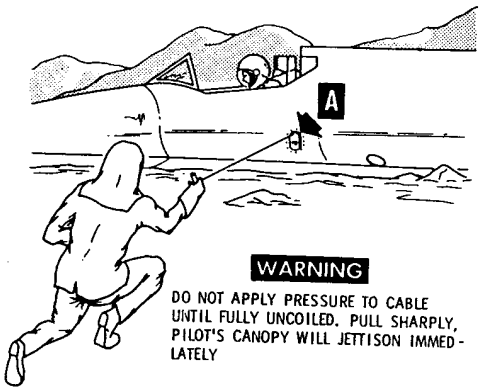


2.



OR

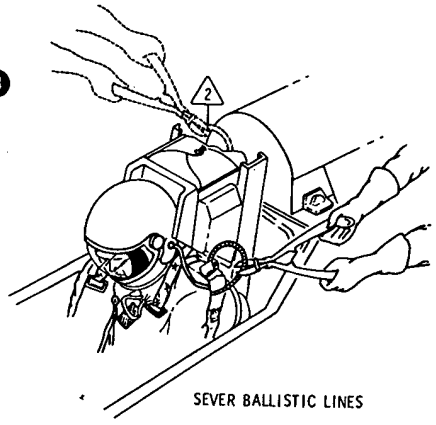
REMOVE JETTISON ACCESS COVER (A) BY PRESSING QUICK DISCONNECT. REMOVE PULL HANDLE. UNCOIL EXCESS CABLE, APPROX. 6 FEET



WARNING

DO NOT APPLY PRESSURE TO CABLE UNTIL FULLY UNCOILED. PULL SHARPLY, PILOT'S CANOPY WILL JETTISON IMMEDIATELY

3.



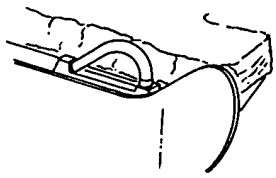
SEVER BALLISTIC LINES

4. OPEN FACE PLATE

PUSH BUTTON DOWN

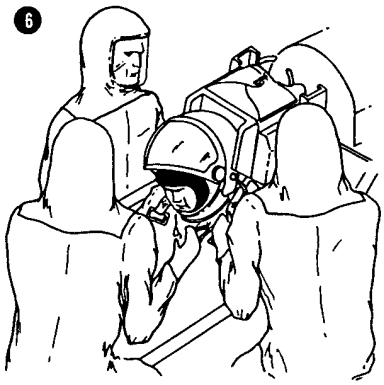
UNHOOK PILOT'S PERSONAL EQUIPMENT

5.



PULL SURVIVAL KIT HANDLE

6.



THREE MEN ARE REQUIRED TO REMOVE PILOT ONE ON EACH SIDE AND ONE ASTRIDE THE COCKPIT IN FRONT OF PILOT

F200-100

Figure 3-2

TAKEOFF EMERGENCIES

PROPULSION SYSTEM

The components considered as parts of the propulsion system include the main engines, afterburners, inlets, nozzles, tailpipes, fuel controls, and fuel-hydraulic, lubrication, and ignition systems. If abnormal operation of any of these components is indicated prior to reaching the acceleration check distance, the takeoff should be aborted. Refer to ABORT procedure, this section. The following procedures apply after satisfactory completion of the acceleration check.

THRUST FAILURE DURING TAKEOFF, TAKEOFF REFUSED

If the acceleration check speed is marginal, or if the thrust of either engine decays or fails, and conditions permit:

1. ABORT.

   Refer to abort procedure, this section.

ENGINE FAILURE IMMEDIATELY AFTER TAKEOFF

If an engine fails immediately after takeoff and the decision is made to continue, maintain Maximum thrust on the operating engine. Lateral and directional control can be maintained when airspeed remains above the minimum single engine control speed. See figure 3-3. However, ability to maintain altitude and to accelerate or climb depends on weight, drag, altitude, airspeed, and temperature. Refer to the appendix for takeoff climb capability data. When at heavy weight for the existing air temperature, dumping fuel may reduce weight sufficiently to remain airborne.

If able to maintain altitude or accelerate:

1. THROTTLES - MAXIMUM THRUST.

   Recheck position of both throttles to assure that maximum power is being obtained.

2. LANDING GEAR LEVER - UP.

3. CROSSFEED SWITCH - PRESS ON.

4. Fuel dump switch - DUMP (if necessary).

   Fuel dumping in addition to consumption by operating engine lightens the aircraft at an appreciable rate. If turning at sufficient speed, the inoperative engine will also discharge fuel from its afterburner.

5. Rudder trim - As necessary.

   Bank and sideslip toward the operating engine as necessary to maintain directional control and minimize drag. 7 to 9 degrees of rudder trim with bank and sideslip as needed to maintain course yields minimum drag in the critical speed range from 220 to 250 KIAS.

6. Throttle (failed engine) - OFF.

WARNING

Positively identify the failed engine before retarding the throttle.

If not mechanical failure:

7. ATTEMPT AIR START (refer to Air Start Procedure this section).

For obvious mechanical failure:

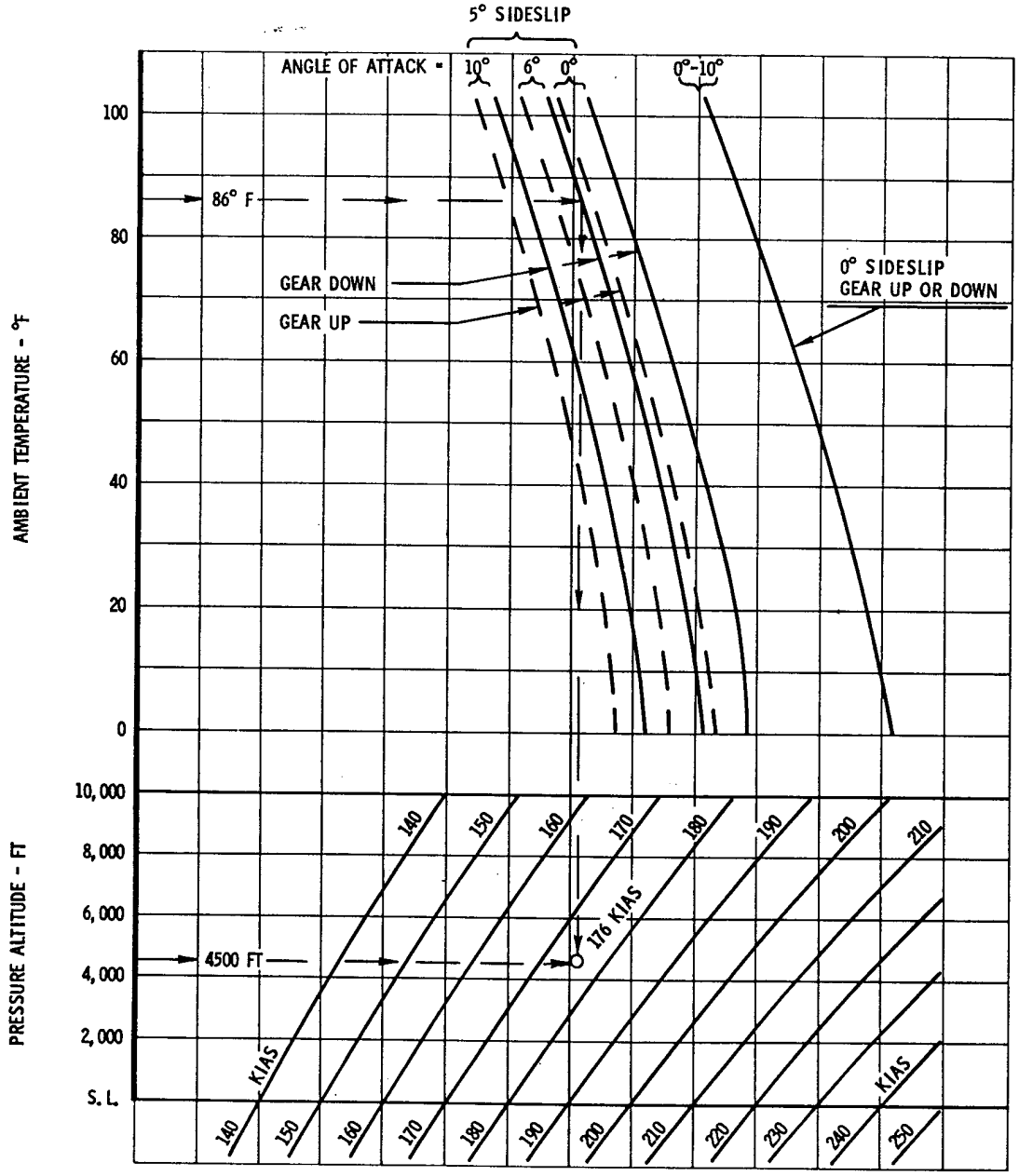
8. Emergency fuel shutoff switch - FUEL OFF.

SINGLE ENGINE MINIMUM AERODYNAMIC CONTROL SPEED

SINGLE ENGINE MINIMUM AERODYNAMIC CONTROL SPEED
– YJ-1 ENGINES –

ONE ENGINE - MAX THRUST
ONE ENGINE - WINDMILLING
20° RUDDER DEFLECTION

BASIS-ESTIMATED DATA -
FROM REVISED W/M DRAG ESTIMATE,
FLT TESTS, AND JJ ENGINE DATA



F200-92

Figure 3-3

DOUBLE ENGINE FAILURE IMMEDIATELY AFTER TAKEOFF

If a double engine failure occurs, proceed as follows:

1. IF GEAR IS DOWN AND CONDITIONS PERMIT - LAND STRAIGHT AHEAD.

2. IF GEAR RETRACTION HAS BEEN INITIATED OR CONDITIONS DICTATE- EJECT.

WARNING

Decay of engine rpm will result in rapid loss of A and B hydraulic system pressure and subsequent loss of aircraft control.

AFTERBURNER FAILURE DURING TAKEOFF, TAKEOFF CONTINUED

If an afterburner fails before leaving the ground and a decision is made to continue, control failed engine as follows:

1. THROTTLE - MILITARY.

2. THROTTLE - MAXIMUM THRUST.

If unable to light afterburner:

3. THROTTLE - MILITARY.

4. Trim - As necessary.

5. Abort mission.

AFTERBURNER NOZZLE FAILURE

Nozzle failure may be indicated by nozzle position, excessive rpm fluctuations, or failure of the engine to control to scheduled speed. This may be accompanied by compressor stall and exhaust gas overtemperature. Engine shutdown may be necessary.

Nozzle Failed Open Immediately After Takeoff

In the event of a nozzle failed open indication:

Affected engine:

1. Throttle - Afterburner range.

2. RPM & EGT - Maintain within limits.

NOTE

In the event of extreme engine overspeed, if flight condition permits, retard throttle below Military or shut down.

3. Land as soon as practicable.

Nozzle Failed Closed

In the event of a nozzle failed closed condition:

Affected engine:

1. Throttle - Military or below, as required.

   Do not attempt to relight the afterburner as the engine may flameout (after which it cannot be restarted due to reduced rpm).

2. RPM and EGT - Maintain within limits.

   Compressor stall is likely, and EGT will probably rise.

3. **Land as soon as practicable.**

FIRE

ENGINE FIRE DURING TAKEOFF - TAKEOFF REFUSED

If either fire warning light illuminates before leaving the ground and the takeoff is refused:

1. ABORT.

   Accomplish ABORT procedure, this section, as necessary.

2. THROTTLE - OFF.
   Affected engine only.

   Positively identify the affected engine before retarding the throttle.

3. EMERGENCY FUEL SHUTOFF SWITCH - FUEL OFF.

4. Shutdown operating engine after stopping.

5. Seat pin - Insert if time permits.

6. Abandon aircraft.

ABORT

The abort procedure assumes that a decision to abort will be made before rotation speed is reached. Aborts from above rotation speed are not prohibited, but the risks associated with aborting from such a high initial speed at takeoff weight must be balanced against those of continuing a takeoff when making the decision. In general, after rotation speed is reached, the most reasonable course of action is to continue rather than abort unless the emergency is such that the aircraft can not fly.

Engine Management

Both throttles should be retarded to IDLE and the brakes applied with the nose down as soon as the decision to abort is made. Reaction time and residual thrust will usually cause airspeed to continue increasing until engine rpm begins to decrease. The planned rotation speed may be exceeded as a result; however, the nosewheel should be kept on the runway to take advantage of nosewheel steering in combination with rudder control. Shutdown of one engine will shorten the stopping distance, but shutdown is not necessary unless the drag chute does not operate properly. In the event of chute failure, shutdown the right engine after both are idling, or complete the shutdown of a failed or flamed out engine.

WARNING

Wait until rpm and EGT show that both engines are idling or that one engine is failing before selecting the engine to shutdown. Loss of both engines may result in loss of hydraulic pressure for braking.

Aircraft Attitude, With Decision to Abort

Lower the nose and energize the brakes simultaneously with nosewheel contact. When rotation is well advanced, the aircraft may accelerate beyond takeoff speed and lift off before rotation can be checked. In this case, hold the aircraft off sufficiently to regain control and then touch down without sideslip if possible. Fly the aircraft back to the runway, attempting to regain the center.

Chute Deployment

The drag chute requires 4 to 5 seconds for deployment after drag chute actuation. It is permissible to actuate the deploy handle while decelerating in anticipation of reaching 210 KIAS; however, premature deployment can result in destruction of the chute. Actuation of the chute system so as to reach 210 KIAS simultaneously with loading of the chute is not recommended unless the risk is justified by a very marginal distance remaining situation.

Brake Switch

The normal ANTI-SKID ON brake switch setting provides nosewheel steering and braking power from the L hydraulic system and anti-skid protection. It is not necessary to change the switch setting unless the left hydraulic pressure has failed or anti-skid off is desired. Selection of ANTI-SKID OFF or ALT STEER & BRAKE causes the ANTI-SKID OUT warning light on the annunciator panel to illuminate.

ABORT PROCEDURE

WARNING

Do not unfasten the lap belt or shoulder harness until the aircraft has come to a stop.

The landing gear should be left in the extended position.

1. THROTTLES - IDLE.

Retard both throttles to IDLE. Do not attempt to shut down either engine immediately unless failure to do so would vitally endanger the aircraft.

2. NOSEWHEEL STEERING - ENGAGE.

3. BRAKES - OPTIMUM BRAKING.

For dry runway: use moderate to heavy brake pressure.

For wet runway: use light to moderate brake pressure.

4. DRAG CHUTE - DEPLOY.

The limit airspeed for drag chute deployment is 210 KIAS.

5. BRAKE SWITCH - As required.

Set the brake switch to ALT STEER & BRAKE when the L hydraulic system is below normal pressure due to system or left engine failure.

CAUTION

Selection of ALT STEER & BRAKE changes the source of brake pressure from the L to the R hydraulic system and disables the anti-skid system.

6. Shut down one engine (if necessary).

Shut down of one engine is considered necessary in the event of drag chute failure.

If drag chute fails to deploy, use DRAG CHUTE FAILURE Procedure, this section.

Shut down the right engine if both engines are idling or if the right engine has failed.

Shut down the left engine if it has failed.

WARNING

Positively identify the failed engine before attempting engine shutdown.

DRAG CHUTE FAILURE

If the drag chute should fail to deploy and stopping distance is critical, proceed as follows:

Dry Runway

1. LOWER NOSE IMMEDIATELY.
2. NOSEWHEEL STEERING - ENGAGE.
3. BRAKES - AS REQUIRED UP TO MAXIMUM BRAKING.
4. RIGHT ENGINE THROTTLE - OFF, IF REQUIRED.
5. HOLD AS MUCH UP ELEVON AS POSSIBLE AND STILL KEEP THE NOSEWHEEL ON RUNWAY FOR DIRECTIONAL CONTROL.

Wet Or Icy Runway

1. LOWER NOSE.
   a. LANDING - AT 110 KIAS
   b. ABORT - IMMEDIATELY AT 190 KIAS.
2. NOSEWHEEL STEERING - ENGAGE.
3. BRAKES SWITCH - NORM.
4. BRAKES - MAXIMUM PRESSURE.
5. RIGHT ENGINE THROTTLE - OFF.
6. HOLD AS MUCH UP ELEVON AS POSSIBLE, BUT KEEP THE NOSEWHEEL ON THE RUNWAY FOR DIRECTIONAL CONTROL.

NOTE

This wet or icy runway technique will probably blow the tires early in the landing roll; however, directional control can still be maintained and the blown tires will remain on the wheels. Additional pedal pressure will be required as each tire blows. Maximum wing aerodynamic braking is more effective than wheel braking on a wet or icy runway until the nose is lowered but the nose up attitude must not be held to a point that the nosewheel will slam onto the runway. Use of maximum possible up elevon after the nose is lowered while keeping the nosewheel on the runway provides aerodynamic drag and additional down load on the main wheels.

FUEL SYSTEM

FUEL PRESSURE LOW WARNING

If one or both FUEL PRESS LOW warning lights illuminate during takeoff, abort if airspeed and runway length remaining permit. If airborne or if an abort is not possible:

1. CROSSFEED - PRESS ON.
2. Tanks with fuel - Press on.
3. Analyze difficulty and attempt to restore normal sequencing.

   Illumination of both fuel pressure low warning lights indicates loss of all boost pumps. This can only result from multiple failures. If this occurs during takeoff, tank pressurization will supply sufficient fuel to the engine driven pumps to maintain engine operation.

WARNING

Fuel can not be dumped with complete boost pump failure. Use caution and observe operating limits of Section V if a heavy weight landing is required.

After fuel pressure restored:

4. Crossfeed - Press off.

If normal operation can not be restored:

5. Land as soon as possible.

With crossfeed on, more fuel may tend to feed from the forward tanks and cause an aft c.g. shift. Before landing, c.g. should be checked carefully.

LANDING GEAR AND TIRES

MAIN OR NOSE GEAR TIRE FAILURE

Failure of a main gear tire during takeoff will overload the remaining tires on that side when takeoff weight exceeds 120,000 lb. This may be precipitate additional tire failures before normal takeoff speed can be reached or before the aircraft can be stopped, depending on speed and the time of failure. As each main gear tire loss decreases the available brake energy capacity by one-sixth, ability to stop from high speed is largely dependent on effectiveness of the drag chute.

Failure of a nosewheel tire is not expected to generate a second tire failure, but it may not be possible to determine immediately whether a nose or main gear tire has failed. In either case, engine or structural damage may be sustained from tire fragments.

Depending on the airspeed attained and whether or not engine damage is indicated, a takeoff may be preferable to aborting.

The following procedure is recommended when a main or nose gear tire failure is suspected during the takeoff run:

1. ABORT IF SPEED PERMITS.

2. ANTI-SKID OFF.

   Set the anti-skid switch OFF prior to brake application. Brake with steady application of pressure to avoid spin-up of the blown tire.

If takeoff is continued:

3. DO NOT RETRACT GEAR until checked.

4. Brake switch - NORM-SKID OFF.

   Anti-skid off must be selected in order to stop the wheels rapidly after takeoff, as braking is disabled with anti-skid ON when gear down selected and there is no weight on the gear.

5. Brake wheels to a stop.

   The blown tire(s) must be stopped in order to minimize the possiblility of damage to the aircraft.

6. Request confirmation of tire and aircraft condition.

   The gear should not be retracted until a visual check has been made by another aircraft or by ground personnel. If loss of one or more tires is verified, the gear should be left extended and a landing made as soon as practicable.

7. Land when practicable.

EMERGENCY GEAR RETRACTION

If the gear lever cannot be moved to the UP position after takeoff:

1. Gear override button - Press and hold.

2. Landing gear lever - UP.

This overrides the solenoid which is normally actuated by the landing gear switch.

WARNING

Improper use of this procedure may cause gear retraction while on the ground.

Once energized, the gear lever must be recycled to the DOWN position in order to bring the ground safety switch back into the circuit.

IN-FLIGHT EMERGENCIES

EMERGENCY ESCAPE

Escape from the aircraft in flight should be made with the ejection seat. The following is a summary of ejection expectations:

a. At sea level, wind blast exerts only minor forces on the body up to 525 KIAS; appreciable forces from 525 to 600 KIAS; and excessive forces above 600 KIAS. The aircraft limit airspeed is below these speeds.

CAUTION

Flights with oxygen mask and regulator are restricted to below FL 500 and below 420 KEAS because of wind blast forces anticipated in the event of ejection. Before actual ejection, airspeed should be reduced to subsonic and as slow as conditions permit.

b. Ejection at 65 KIAS and above during takeoff or landing run results in successful chute deployment.

c. The free fall from high altitude down to 15,000 feet with drogue chute stabilization will result in stabilized descent in the quickest manner.

During any low altitude ejection, the chance for success can be greatly increased by zooming the aircraft to exchange excess airspeed for altitude. Ejection should be accomplished while the aircraft is in a level or climbing attitude. A climbing or level attitude will result in a more nearly vertical trajectory for the seat and crew members, thus providing more altitude and time for seat separation and parachute deployment.

The zero altitude capability of this aircraft should not be used as a basis for delaying ejection if ejection is necessary. Aircraft accident statistics emphatically show a progressive decrease in successful ejections as ejection altitude is decreased below 2000 feet; therefore, whenever possible, eject above 2000 feet.

BEFORE EJECTION

Before ejection, when time and conditions permit:

1. Altitude - Reduce so that the pressure suit is not essential to survival.
2. Airspeed - Reduce to subsonic and as slow as conditions permit.
3. Head aircraft toward unpopulated area.
4. Transmit location and intentions to nearest radio facility.
5. IFF - EMER position.
6. Lower helmet visor.
7. Green apple - Pull if above 15,000 feet.

EJECTION

To accomplish an emergency escape using the ejection seat proceed as follows:

1. ASSUME PROPER BODY POSITION.

   Sit erect with head against head rest. If possible, cross arms to pull ejection ring to assist in keeping arms close to body.

2. PULL EJECTION "D" RING.

If seat fails to eject after normal delay, continue with the following:

3. JETTISON CANOPY.

Use canopy jettison handle. If canopy still does not jettison, open canopy and allow it to blow off into the air stream.

4. PULL EJECTION T-HANDLE.

WARNING

Do not pull the T-handle with the canopy still in place.

Keep elbows close to sides and feet firmly against seat while pulling the ejection T-handle since the foot retractors and knee guards will not actuate.

AFTER EJECTION

After clear of aircraft if not automatically separated from seat:

1. Manual cable cutter ring - Pull.
2. Seat belt - Open.
3. Kick loose from seat.
4. Parachute arming lanyard - Pull.

If at high altitude after drogue chute stabilizes free fall:

5. Extend arms to control spinning.

When drogue chute releases:

6. Feet together.

CAUTION

After drogue chute separation, backward tumbling tendency occurs. Feet together prevents pilot chute deployment between legs.

PARACHUTE LANDINGS

After main chute opens:

Over Land - High Altitude

a. At approximately 2000 feet, release your survival kit. Pull handle completely free of the kit.

b. At approximately 1000 feet, roll - safety Rocket Jet roll bars up.

c. Prepare to land.

d. After landing, release one side of your parachute to prevent being dragged by winds.

Over Land - Low Altitude

a. Release kit immediately after parachute opening shock.

b. Prepare to land.

Over Water - High Altitude

a. Open face plate and extend microphone boom to hold open.

b. Disconnect emergency oxygen hose leads.

c. Loosen chest strap.

WARNING

Failure to loosen chest strap before inflating flotation gear may result in inability to breathe.

d. Pull out life vest oral inflation tube and check open valve.

e. Disconnect vent hose.

f. Inflate life vest - time permitting, close oral inflation valve.

g. 1500 to 2000 feet, release survival kit.

h. Roll riser release safety bars to the up position (RJ releases).

i. Place left forearm through the "V" formed by the left risers.

j. Place right hand on left riser release, feet together and knees slightly bent.

k. Push up on the left riser release on contact with water, releasing canopy.

l. Release other (right) side of the canopy.

m. Pull raft to you for additional support.

n. Disconnect the survival kit lanyard from the right side of the parachute harness.

o. Remove spurs before boarding raft.

CAUTION

Spurs must be removed to prevent puncturing raft.

p. Remove parachute harness before boarding raft.

q. Board raft.

Over Water - Low Altitude

a. Immediately inflate outer garment after parachute opens.

b. Release survival kit.

c. Roll Rocket Jet release roll bars up. Jettison canopy upon contact with water.

d. Follow standard procedures in water.

BAILOUT WITH EJECTION SEAT INOPERATIVE

If the seat fails to eject, the following procedure should be used to leave the aircraft.

1. Airspeed - 250 to 300 KEAS.

2. Green apple - Pull.

3. Foot spurs - Release.

4. Personal leads - Disconnect.

   Disconnect oxygen supply hoses at the quick disconnect, and suit vent hose at the controller.

5. Trim full nose down, roll inverted.

6. Lean forward.

7. Release seat belt (and control stick, simulataneously) and drop out.

When clear of aircraft:

8. Pull parachute arming lanyard.

9. Prepare for landing.

   Preparations for landing are the same as for ejection procedure.

FIRE

FIRE WARNING IN FLIGHT

Illumination of a FIRE warning light indicates a nacelle compartment temperature above approximately 1050°F. An immediate check should be made for abnormal EGT and, if possible, for trailing smoke or any other indication of fire. In case of doubt, assume that a fire does exist and proceed as follows:

1. THROTTLE - MILITARY (AFFECTED ENGINE).

If light remains on:

2. THROTTLE - IDLE ABOVE MINIMUM CONTROL SPEED.

If light still remains on:

3. THROTTLE - OFF.

   If fire warning light extinguishes while shutting down the engine, do not attempt a restart.

4. EMERGENCY FUEL SHUTOFF SWITCH-FUEL OFF.

WARNING

Shutting off the fuel if speed above approximately Mach 2.2, may cause engine oil to overheat and result in engine failure. Shutting off the fuel may also cause additional emergencies due to loss of the associated aircraft cooling systems. Reduced Mach number decreases cooling requirements because of lower environmental temperatures.

NOTE

If it is the left engine which is suspected and has been shut down, the cockpit air switch should be placed in the EMER position.

5. CHECK FOR OTHER INDICATIONS OF FIRE.

At pilot's discretion, if fire confirmed or confirmation not possible and light remains on:

6. EJECT. Attempt to descend from extremely high altitude prior to ejection.

If there is no fire:

7. Land as soon as possible.

SMOKE OR FUMES

The pilot cannot detect fumes when wearing a pressure suit. The helmet oxygen system is independent of the cockpit and suit air supply. Smoke can be eliminated promptly by dumping cabin pressure unless smoke is entering the cockpit from the air conditioning system.

WARNING

Cockpit depressurization will occur at an extremely rapid rate and the pilot will be dependent on his pressure suit for altitude protection.

If the smoke is introduced by the cockpit air supply system, switch the cockpit system to EMERG. The defog system should be off at all times when not required.

If smoke is entering the cockpit from the air conditioning system:

1. Cockpit air switch - EMER.

2. Defog switch - OFF if not required.

If smoke or fumes cannot be controlled:

3. Initiate emergency descent.

ELECTRICAL FIRE

The pilot must depend on visual detection of electrical fire when wearing a pressure suit since he cannot smell the characteristic odor.

1. Isolate the malfunction.

   Turn off electrical systems in order to isolate the malfunction(s). If necessary, deactivate suspected systems by pulling circuit breakers. The battery and one generator may be turned off without adverse effect on essential systems; however, both generators should not be off simultaneously unless absolutely necessary as this would shut down all fuel boost pumps.

2. Leave failed system off.

If required:

3. Cockpit pressure dump switch - DUMP.

4. Land as soon as possible.

EMERGENCY DESCENT

If extreme conditions require a rapid descent:

1. THROTTLES - IDLE.

2. RESTART SWITCHES - BOTH ON (SIMULTANEOUSLY)

   CAUTION

   When initial CIT is high, engine damage can be expected as the deceleration Mach rates specified in Section V will be exceeded.

3. AFT BYPASS SWITCHES - OPEN.

Setting this configuration provides the least probability of asymmetric unstart, high drag, and the best means for avoiding inlet roughness during the descent.

CAUTION

Set the aft bypass CLOSED if engine speed is maintained at or near the Military rpm schedule. Engine stalls will occur below Mach 2.6 if the forward and aft bypass are open with rpm at or near Military speed.

4. Airspeed - Adjust between 350 to 400 KEAS.

WARNING

Do not exceed 450 KEAS or 1.6 g load factor.

If necessary, reduce rate of descent to maintain positive fuel tank pressure.

Increase rpm if high suit inflow temperatures are experienced.

5. Forward transfer switch - FWD TRANS.

For rapid descents during which aircraft control has become or may become critical (i.e., pilot emergency, aft c.g. location with boost pumps inoperative) a minimum use of flight controls is recommended. This may include non-turning flight until lower speeds are attained. If aircraft control is not a critical consideration (i.e., low oxygen quantity) a spiral descent is very effective in providing a more rapid loss of altitude.

In descending through the transonic region, the nose will be between 10 and 30 degrees below the horizon.

CAUTION

Turns causing appreciable load factor should be avoided while descending through the 50,000 foot level as the pitch SAS gain switching will cause a transient "bump" which may increase load factor to near limit value.

When subsonic:

6. Landing gear lever - DOWN. (Below gear limit speed.)

WARNING

Gear extension at supersonic speeds is forbidden.

CAUTION

If the landing gear is extended above 300 KEAS or Mach 0.9, the landing gear doors will be damaged if sideslip exists.

Extending the landing gear at speeds above Mach 2.3 may cause heat damage to tires and result in a hazardous landing condition. With gear extended, a large nose-up pitch moment occurs in the speed range of Mach 1.6 to 0.9. Full nose-down elevon will be insufficient to maintain 1-g flight at high KEAS and/or aft c.g. in this area.

FUEL DUMPING PROCEDURE

Normal fuel dumping provides a means of reducing gross weight rapidly in the event of an emergency. All tanks containing fuel except for tank 1 will empty in the normal fuel tank usage sequence. Tank 1 will not be dumped, as its boost pumps are held off by actuation of the fuel dump switch and manual actuation of the tank 1 boost pump selector turns dumping off. When the fuel dump switch is in the DUMP position, fuel dumping will continue only until the fuel level in tank 4 reaches 5000 pounds. When the EMER position is selected, dumping will continue until all fuel excluding tank 1 is expended. To increase the dump rate, manually select boost pumps for all tanks containing fuel (except tank 1).

NORMAL FUEL DUMPING

Accomplish normal fuel dumping as follows:

1. Fuel dump switch - DUMP.
2. Fuel quantity - Alternately monitor TOTAL fuel and tank 4 fuel.
3. Fuel dump switch - OFF when 5000 pounds remain in tank 4.

EMERGENCY FUEL DUMPING

If the fuel level in tank 4 has prematurely reached the 5000 pound level and dumping is required (excessive fuel in tanks 3, 5 or 6), proceed as follows:

1. Fuel dump switch - EMER.
2. Tanks 3, 5 or 6 containing fuel - Press on.
3. Forward transfer switch - FWD TRANS (if required).
4. Fuel quantity - Alternately monitor tanks 1 and 4.

When tank 1 quantity reads 4000 pounds:

5. Forward transfer switch - OFF.

When required amount of fuel remains:

6. Fuel dump switch - OFF.

WARNING

The boost pumps in tank 1 are inoperative until the EMER dump is turned OFF or tank 1 pumps are selected manually. The EMER dump must be turned to OFF or DUMP to assure automatic availability of fuel remaining in tank 1 at termination of fuel dumping.

FORWARD FUEL TRANSFER AND FUEL DUMPING PROCEDURE

Forward fuel transfer and fuel dumping may be accomplished simultaneously as follows:

1. Fuel dump switch - DUMP.
2. Forward transfer switch - FWD TRANS.
3. Fuel quantity - Alternately monitor tanks 1 and 4.

When tank 1 fuel quantity reads 4000 pounds:

4. Forward transfer switch - OFF.
5. Fuel dump switch - OFF when 5000 pounds remain in tank 4.

FORCED LANDING OR DITCHING

Ditching, landing with both engines inoperative, or other forced landing should not be attempted. Ejection is the best course of action. All emergency survival equipment is carried by the pilot; consequently, there is nothing to be gained by riding the airplane down.

At least one engine must be operating if a forced landing is to be attempted. All forced landings should be made with the landing gear extended regardless of terrain. High airspeed or nose high angle of impact during landings with gear retracted causes the aircraft to "slap" the ground on impact, subjecting the pilot to possible spinal injury. It is recommended that a gear up landing not be attempted with this aircraft; EJECT instead.

PROPULSION SYSTEM

The following procedures are to be accomplished in the event of abnormal operation or failure of a propulsion system component, i.e., inlet, engine, afterburner, nozzle, fuel control, or lubrication, fuel-hydraulic, or ignition system.

INLET DUCT UNSTART

Inlet duct unstarts can only occur after supersonic speeds are reached and an inlet has been "started", that is, supersonic flow conditions established inside part of the inlet. Normally, the supersonic flow region extends from the cowl entrance to a position near the inlet throat when inlet flow conditions are optimized. A shock wave is formed at the boundary between supersonic and subsonic flow conditions in the inlet. When an inlet unstarts, the internal shock wave is expelled and a "normal" shock wave forms ahead of the cowl. Flow within the inlet becomes subsonic and pressure in the inlet decreases. When an inlet alternately starts and unstarts rapidly, the change in inlet pressure which occurs results in severe airframe roughness.

Shock expulsion, or unstart, may be caused by inlet airflow becoming greater than

engine requirements and duct bypass capability, spike position too far aft, or abrupt aircraft attitude changes. Improper spike or door positions can result from inlet control error, loss of hydraulic power, or electrical or mechanical failure. Unstarts are usually associated with climb or cruise operations above Mach 2 when at normal engine speeds; however, they may be encountered during reduced rpm descents at speeds above Mach 1.3. Between Mach 1.3 and 2.2, when near Military rpm, recovery procedures using the restart switch ON position may result in compressor stall.

Unstarts are generally recognizable by airframe roughness, loud "banging" noises, aircraft yawing and rolling, and decrease of compressor inlet pressure toward 4 psi. Fuel flow decreases quickly and the afterburner may blow out. EGT usually rises, with the rate of increase being faster when operating near limit Mach number and ceiling altitudes. A distinct increase in drag and loss of thrust occurs because of increased air spillage around the inlet and reduced airflow through the engine.

The aircraft yaws toward the unstarted inlet during an unstart. This yaw causes a roll in the same direction. Pitch rates are not developed by the inlet unstart, but pitch control problems can occur during associated maneuvering and will be accentuated by aft c.g., high Mach numbers and any pitch rate which existed prior to inlet unstart. During the unstart, primary emphasis must be placed upon maintaining pitch control in order to prevent nose up pitch rates and angles of attack in excess of eight degrees. Thrust asymmetry should be reduced as soon as possible.

Aileron effectiveness is reduced at high altitudes and high angles of attack. Roll control may become critical if the unstart occurs on the inboard inlet during a bank. At altitudes above 75,000 feet, aileron control may be ineffective in controlling roll during an unstart unless the angle of attack is immediately reduced. Aileron effectiveness increases rapidly as the angle of attack is reduced and only moderate aileron inputs will be required to control the roll. An excessive nose down attitude may result in an over speed in KEAS and Mach if the inlets are restarted during a recovery maneuver. Therefore the restart switches should remain on until speed and attitude are fully under control.

The roughness usually clears after the forward bypass doors open and the spikes are started forward manually or automatically; however, as much as five to eight seconds may be required for the spikes to reach the full forward position. Roughness may persist until the spikes are fully forward during restarts at design Mach number.

Inlet pressure should be checked during recovery. Moderate CIP increases will occur as the inlet "clears" or restarts, and when the spike retracts to form the inlet throat farther aft. Return of the forward bypass doors to their normal operating schedule should result in a further CIP increase to normal operating values.

In automatic operation, unstarts which are caused by improper spike scheduling limit aircraft speed to Mach numbers below that for the unstarted condition. Manual scheduling procedure is necessary if the aircraft is to be accelerated further. If an unstart results from marginal bypass scheduling however, it may be possible to continue at speed by adjusting the forward or aft inlet bypass doors to positions which maintain stable flow conditions. In general, if engine speed is maintained, less bypass area is required as limit Mach number is approached.

Figure 3-4 shows the operating conditions where airframe roughness will occur due to unstable inlet airflow conditions. The unstart boundaries are a function of Mach number, engine speed, and spike and bypass door positions. The smallest roughness area occurs below the idle rpm range with the forward and aft bypass doors open and spike full forward. A more extensive area occurs with the bypass doors open but with

INLET UNSTART BOUNDARIES

SPIKE: FORWARD
FORWARD BYPASS: OPEN
OR
RESTART : ON

STANDARD DAY -
Based On Mach And FAT
For Std. Day At 400 KEAS

NOTE: Unstart boundaries will increase approximately 150 RPM for each 10°C temperature increase above ambient standard day temperature.

Unstart Boundaries Indicate The Minimum RPM Obtainable Without Unstart For A Specific Mach And Inlet Configuration

YJ ENGINES - YJ-1 ENGINES
WITH HAMILTON STANDARD
MAIN FUEL CONTROL

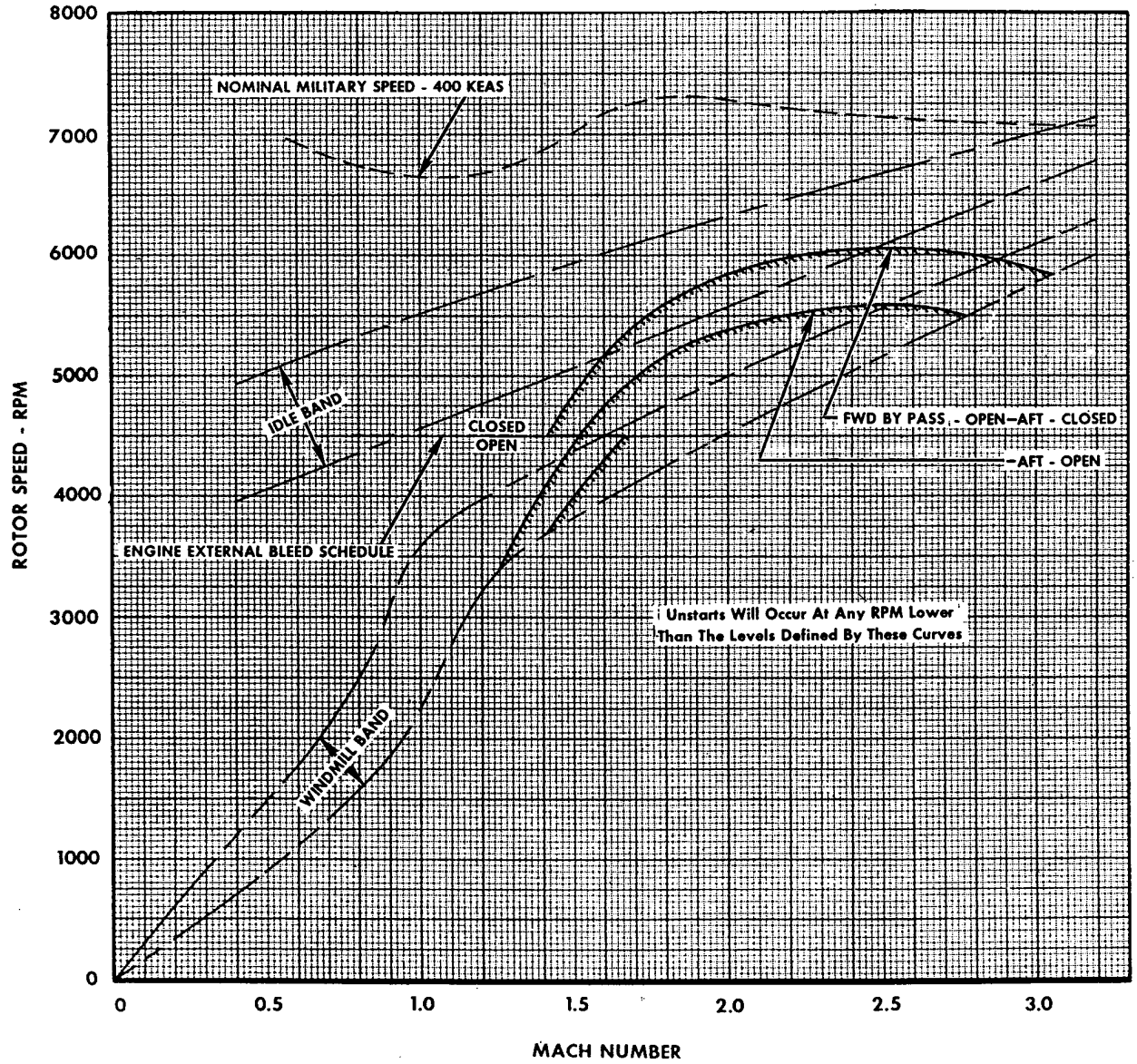


Figure 3-4
(Sheet 1 of 2)

INLET UNSTART BOUNDARIES

SPIKE: AUTO
FORWARD BYPASS: MANUAL

STANDARD DAY -
Based On Mach And FAT
For Std. Day At 400 KEAS

NOTE: Unstart boundaries will increase approximately 150 RPM for each 10°C temperature increase above ambient standard day temperature.

Unstart Boundaries Indicate The Minimum RPM Obtainable Without Unstart For A Specific Mach And Inlet Configuration

YJ ENGINES - YJ-1 ENGINES WITH HAMILTON STANDARD MAIN FUEL CONTROL

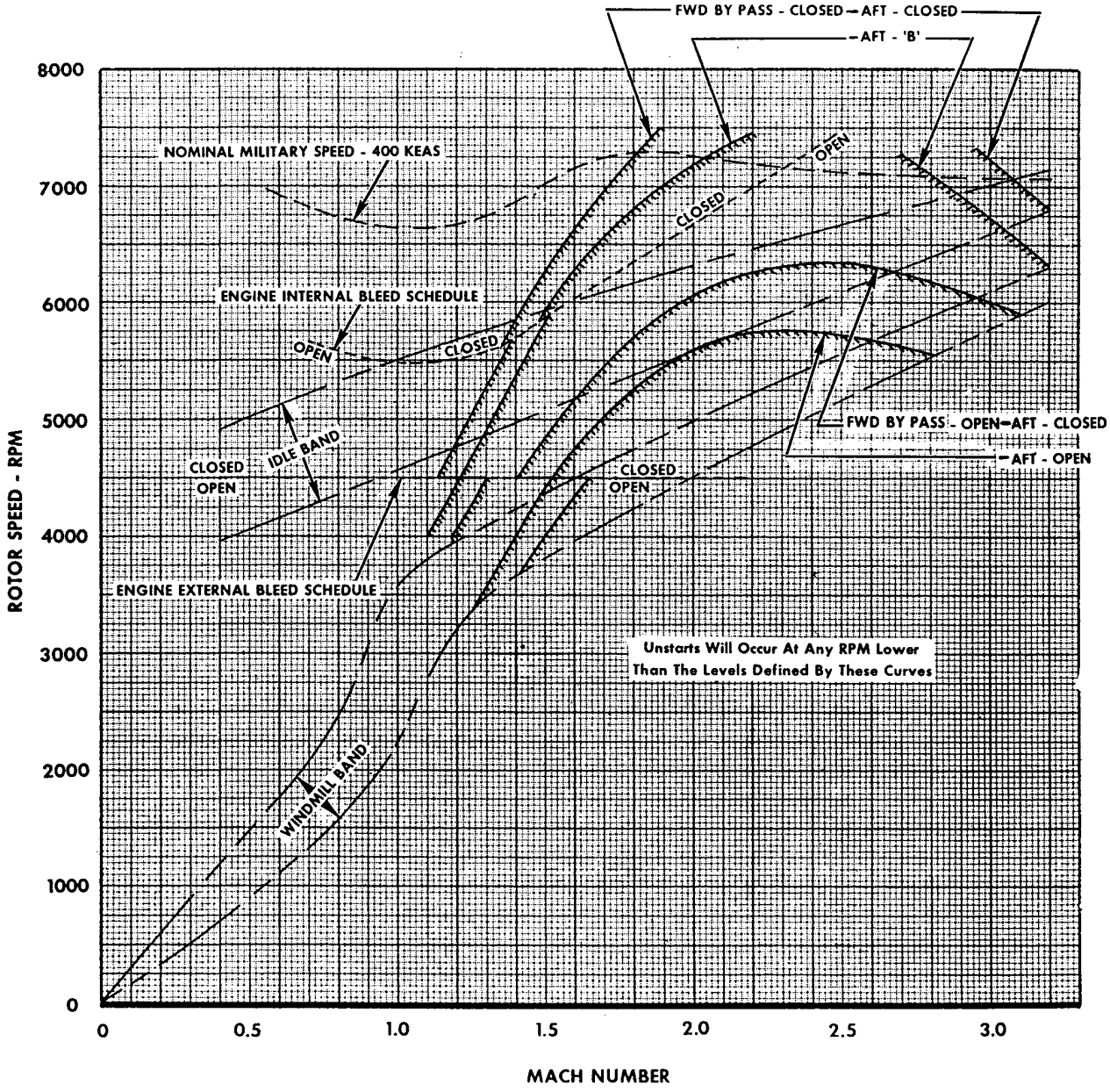


Figure 3-4
(Sheet 2 of 2)

the spike moving in accordance with the automatic schedule. In both cases, the onset of inlet airflow instability occurs earlier, i.e., at higher engine speeds, with the bypass doors closed. At windmilling rpm, heavy roughness will occur in the speed range above Mach 1.3 regardless of spike and door positions.

In the event of an unstart, accomplish only those of the following steps which are necessary to clear the inlet and return to normal operation.

CAUTION

Shut down the engine if an EGT overtemperature exists for more than five seconds, then restart the inlet and the engine as soon as possible.

In the event an inlet duct unstarts, proceed as follows:

1. SIMULTANEOUSLY DISENGAGE AUTOPILOT, REDUCE ANGLE OF ATTACK, AND SELECT BOTH RESTART SWITCHES ON.

WARNING

Do not attempt to clear the unstarted inlet by placing only one restart switch on.

2. BOTH THROTTLES - MILITARY.
3. MAINTAIN ATTITUDE CONTROL - OPTIMIZE PITCH AND ROLL.
4. AIRSPEED - ADJUST TOWARD 350 KEAS. DO NOT EXCEED MACH 3.1.

If roughness does not clear after 10 seconds:

5. AFT BYPASS switch - OPEN.

When roughness clears:

6. Aft bypass switch - Normal schedule.
7. Restart Switches - FWD BYPASS OPEN (individually)
8. Restart switches - OFF (individually).

After inlet starts:

9. Fuel derichment arming switch - Recycle below 790°C EGT if derich actuated.
10. Throttles - As required.

If unstarts repeat or inlet roughness does not clear:

11. Engine and inlet instrument and hydraulic pressure - Check.
12. Repeat procedure.

If unstarts persist:

13. Attempt inlet restart and operation using manual inlet controls.

INLET CONTROL MALFUNCTION

Automatic Spike Control Malfunction

Manual spike control is necessary if an automatic spike control manfunctions. In this event, the spike and forward and aft bypass must be operated manually as prescribed in the schedule table. Use of the AUTO forward bypass setting results in open forward doors when manual spike positions are selected.

Automatic Forward Bypass Control Malfunction

With the automatic spike control operating normally, there are two options available for control of the forward bypass doors in the event their automatic control malfunctions. The manual bypass schedule table may be used, or, if the opposite side inlet controls are operating normally, the forward bypass manual setting may be adjusted to provide CIP which is at least 1 psi below the normal side indication. Note that during automatic spike and manual bypass operation, bypass position is controlled only by the pilot, and bypass position is not affected by spike position. Therefore, it is necessary to anticipate changes in flight speed or attitude which affect matching of the CIP indications.

Operation With Manual Inlet Control

Maximum allowable speed is Mach 3.0.

Manual inlet scheduling must not be used above 80,000 feet.

To increase longitudinal stability, sufficient fuel should be transferred forward to obtain at least 0° pitch trim. This decreases the possibility of making inadvertent attitude changes which would affect CIP matching. Nose down pitch trim is an indication of adverse cg for this condition. However, the need for forward transferring should be weighed against the decrease in ceiling and range capability associated with increased pitch trim requirements at forward c.g.

Maximum bank angles of 30 degrees are permissible at speeds up to Mach 3.0. However, when a small heading change is desired, using a smaller bank angle will reduce the possibility of an unstart.

When 20 degrees bank angle will be exceeded, the forward bypass should be adjusted to one position number lower than specified in the manual schedule; then the spike should be adjusted to 0.1 Mach number position less than indicated by the TDI. After completion of the turn, the inlet controls may be readjusted to the manual schedule. The spike should be reset first, then the forward bypass.

MANUAL SPIKE SCHEDULE

The following schedule must be used when automatic scheduling is ineffective.

Acceleration - Lag Mach number by 0.1 Mach

Cruise - Match Mach number.

Deceleration - Lead Mach number by 0.1 Mach (e.g., spike at 1.9, Mach setting at 2.0 Mach on TDI).

MANUAL BYPASS SCHEDULE

The following schedule must be used with manual spike scheduling. It is optional when the spike and opposite inlet are operating normally.

Condition	Mach	Fwd Byp.	Aft Byp.
Acceleration & Cruise	Above 1.7	Set at least 1 psi CIP below the stripped pointer.	Pos. B
Acceleration & Cruise	Above 2.8		CLOSED
Deceleration	ALL	Open	CLOSED

INLET UNSTABLE

Unstable inlet conditions which produce inlet and airframe roughness occur at supersonic speeds when an inlet alternately unstarts and restarts rapidly, usually during deceleration at reduced rpm. Inlet unstart procedures are used first, except that the

throttle normally is reset to provide Military rpm instead of afterburning thrust after the unstart is cleared. Subsequent settings may be made as desired. Refer to procedure for compressor stalls in descent.

Failure of a Spike to Schedule or Inlet Spike Unstable

A combination of unsymmetrical thrust and low compressor inlet pressure on one side when accelerating between Mach 1.6 and Mach 2 indicates that a spike has failed to move aft on the proper schedule. This may be caused by failure of the spike forward lock to disengage above 30,000 feet altitude.

Spike instability is reflected by fluctuations of the respective hydraulic pressure gage. If spike oscillations are of large amplitude the gage fluctuations will be several hundred psi and will be indicated on the spike position indicators. If an unstable spike or failure to schedule is suspected, proceed as follows:

1. Spike position - Check while between 1.6 and 2.0 Mach number.

2. Spike control - Cycle FWD then return to AUTO.

If condition continues:

3. Forward bypass control - Manual schedule.

4. Spike control - Manual schedule.

As higher Mach number is reached:

5. Spike and forward bypass controls - AUTO.

If condition recurs or continues:

6. Operate per spike and bypass manual schedule.

COMPRESSOR STALLS

Acceleration and/or Overtrim

These stalls usually result from EGT uptrim and are most prevalent during throttle application at subsonic speeds and low compressor inlet temperatures. They may also occur with constant throttle settings at or below Military at any airspeeds. Retarding the throttle should result in the fastest stall recovery. Downtrim and readjustment of the throttle should result in proper engine operation.

1. THROTTLES - RETARD UNTIL STALL CLEARS.

2. EGT trim switches - HOLD DOWN 1 to 3 seconds.

3. THROTTLES - As desired.

4. If stall persists repeat above procedure.

5. If stall cannot be cleared - Land as soon as possible.

Compressor Stalls in Descent

The airframe roughness characteristics felt during compressor stalls at supersonic speeds are very similar to those which occur during inlet unstarts. If roughness is encountered, an unstart condition is more likely while above Mach 2.5 when spike scheduling is at fault. A compressor stall condition is more likely at lower supersonic speeds when at or near Military rpm with excessive bypass door opening. The normal descent procedure tends to avoid conditions which may result in compressor stalls, but excessive rpm reduction or spike too far aft precipitates unstarts. (See figure 3-4.) It is best to employ the unstart procedure first in the event of inlet disturbances until it is apparent that the spike is scheduling and that spike forward

STALL BOUNDARIES

SPIKE: FORWARD
FORWARD BYPASS: OPEN
OR
RESTART : ON

STANDARD DAY -
Based On Mach And FAT
For Std. Day At 400 KEAS

YJ ENGINES - YJ-1 ENGINES
WITH HAMILTON STANDARD
MAIN FUEL CONTROL

Stall Boundaries Indicate The Maximum RPM Obtainable
Stall-Free For A Specific Mach And Inlet Configuration

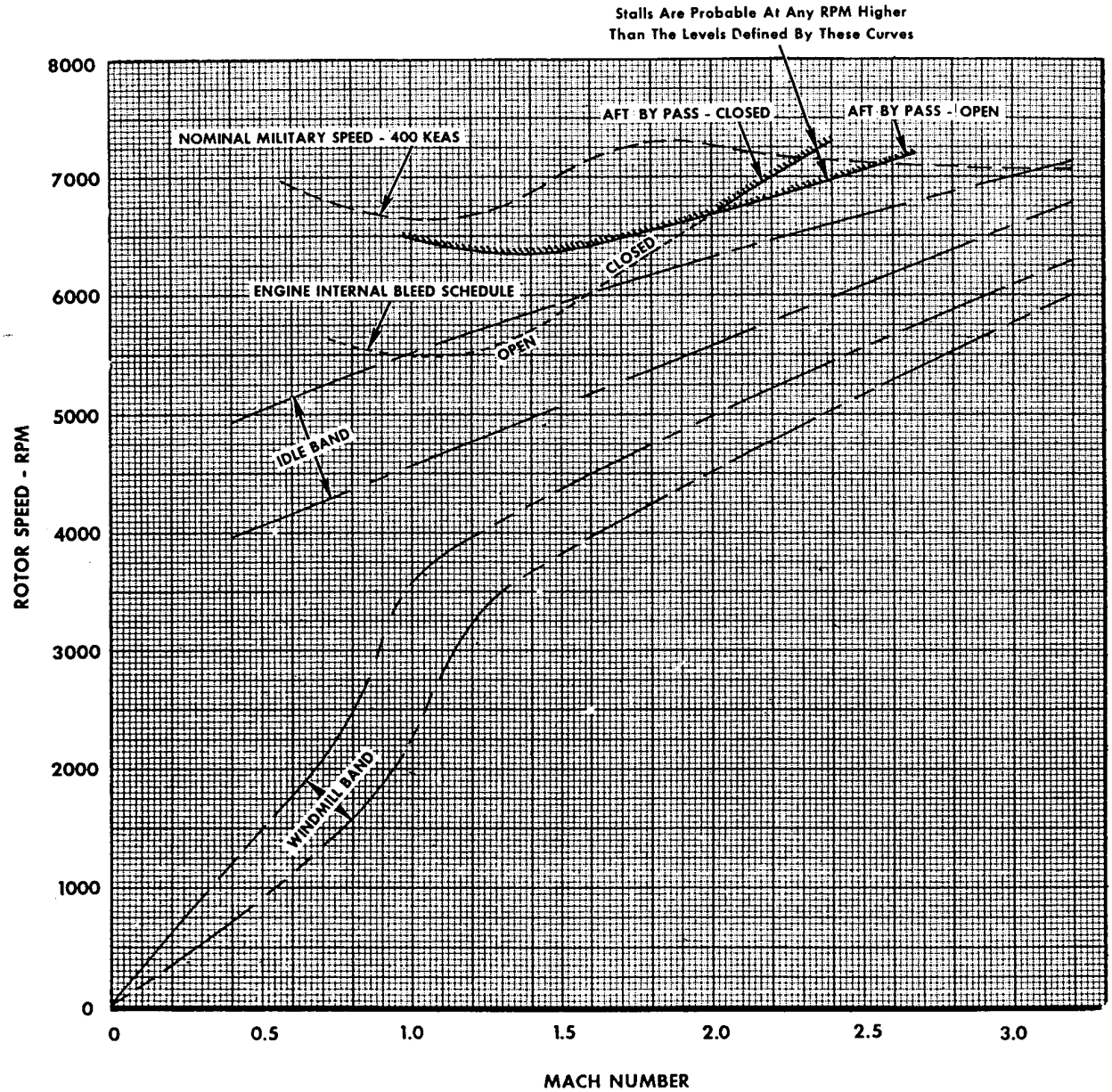


Figure 3-5

is ineffective in clearing the roughness. The throttle should then be retarded slowly to the idle stop if necessary, until roughness stops and the compressor stall is cleared. Maintain this configuration for the remainder of the descent until subsonic airspeeds are reached.

1. Restart switch - ON.

2. Throttle - Reduce rpm slowly until stall clears.

When subsonic:

3. Restart switch - OFF.

ENGINE FLAMEOUT

Windmilling operation at speeds between Mach 1.5 and 2.3 may result in heavy inlet roughness as illustrated by figure 3-4. If an immediate airstart cannot be obtained before the engine stabilizes at windmilling speeds, adjust airspeed to obtain 375 KEAS or at least 7 psia CIP before making further attempts. Engine flameout with afterburners on or off should be treated identically except for initial throttle positioning after the flameout occurs. If flameout occurs with afterburners ON, the throttles should be retarded to minimum afterburner position to reduce thrust asymmetry. If afterburners are OFF at flameout the operating engine should be set to the thrust required by flight conditions. When an engine flameout is confirmed by crosschecking EGT, fuel flow, rpm and ENP, proceed as follows:

1. THROTTLES - AS REQUIRED.

2. DETERMINE FLAMED OUT ENGINE.

3. ACCOMPLISH AIRSTART PROCEDURE.

If start is not successful - Failed engine:

4. Throttle - OFF.

5. Generator - TRIP.

6. CROSSFEED light - Check on.

7. Compressor inlet pressure normal range - Check above 7 psia.

8. Throttle - Half open. (Check TEB remaining).

NOTE

If necessary, continue airstart attempts as long as TEB supply remains unless an obvious mechanical failure has occurred.

After start:

9. Throttles and cockpit switches - As required.

If mechanical failure obvious or unable to start engine:

10. Throttle - OFF.

11. Failed engine inlet air forward and aft bypass door controls - OPEN above Mach 1.4.

12. Cockpit air switch - EMER if left engine failed.

13. Establish single engine cruise.

DOUBLE ENGINE FLAMEOUT

When altitude permits:

1. ATTEMPT AIRSTART.

When altitude is critical, or engines will not start:

2. EJECT.

WINDMILLING GLIDE DISTANCE

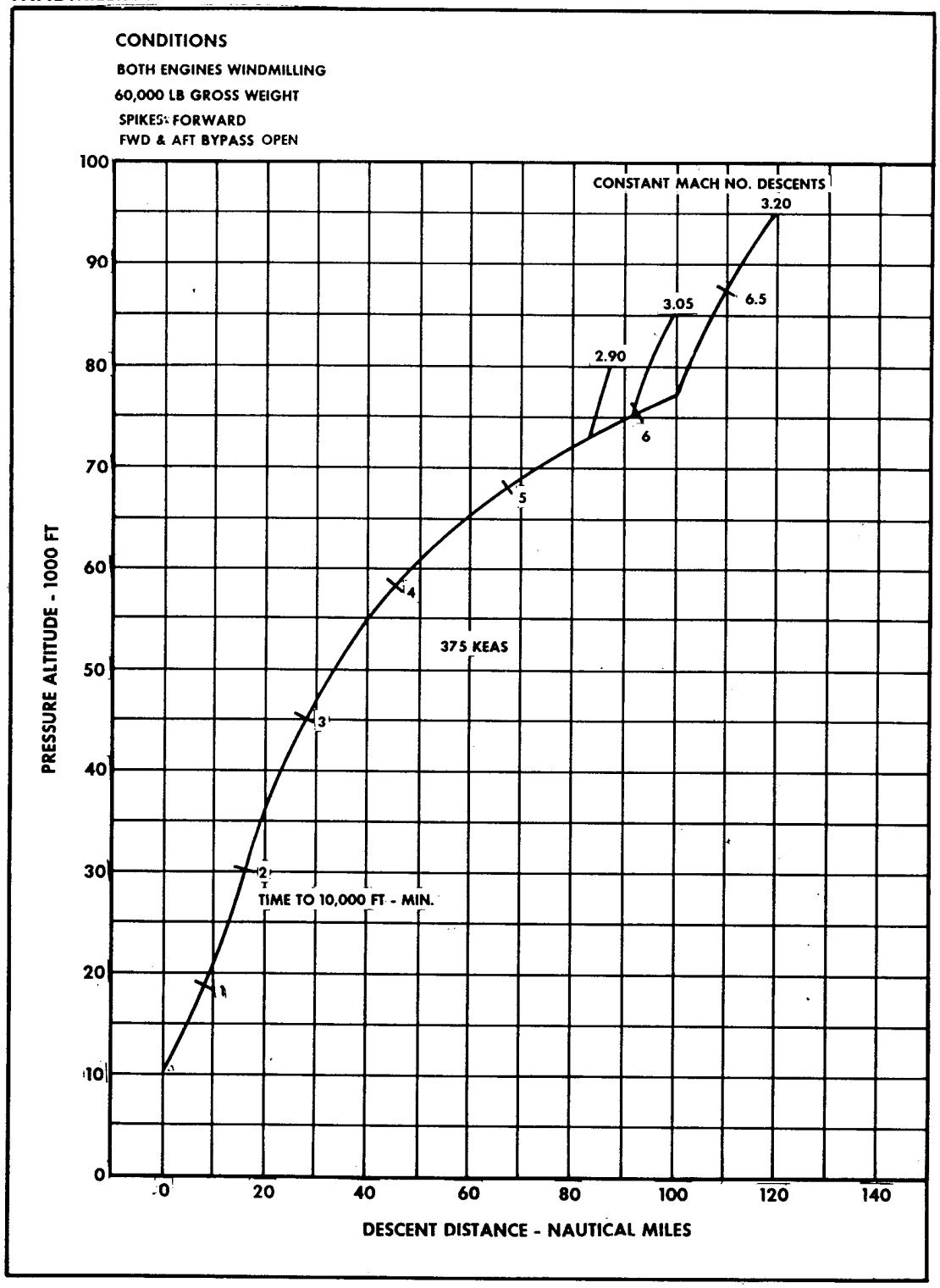


Figure 3-6

AIRSTART PROCEDURE

NOTE

The reason for initial engine shutdown must be considered prior to initiation of restart.

The recommended condition for airstarts at any Mach number is 375 KEAS with CIP 7 psi or greater. Airstarts should not be attempted at lower inlet pressures, and airspeeds in excess of 400 KEAS should not be required in obtaining 7 psia. Conditions for airstart are more favorable when stable inlet condition exist; however, starts have been obtained while in roughness. Monitor rpm, EGT and fuel flow while making the start attempt. Allow 15 seconds, after advancing the throttle, for rpm and EGT rise as an indication of successful start. The recommended procedure for airstarts is as follows:

1. THROTTLE - OFF.
2. AIRSPEED - ADJUST TO OBTAIN 7 PSIA CIP.
3. FORWARD BYPASS SWITCH - OPEN.
4. CROSSFEED - ON.
5. THROTTLE - HALF OPEN.

After start:

6. Throttle and cockpit switches - As required.

If start unsuccessful (after 30 seconds):

7. Throttle - OFF.
8. Repeat AIRSTART attempt (check TEB counter).

CAUTION

- The engine shall not be intentionally windmilled at subsonic conditions when CIT is less than 15°C (60°F). If it is necessary to windmill the engine for more than five minutes the engine should not be restarted.
- If the engine must be restarted during an in-flight emergency after windmilling in excess of the above limit maintain as high an airspeed as possible to raise the inlet air temperature prior to starting. The engine should then remain at idle until there is an indication the oil has warmed up either by extinguishing of the oil temperature warning light if it has illuminated or by a normal response of oil pressure to throttle movement to slightly above IDLE.
- If, following windmill operation in excess of the above limit, the engine must be restarted and operated at high thrust levels while the oil temperature light is illuminated, duration of such operation shall be as brief as possible.

GLIDE DISTANCE-BOTH ENGINES INOPERATIVE

The windmilling Glide Distance chart, figure 3-6, shows zero-wind distances with both engines windmilling. The glide speeds are in the same range as for airstart. Somewhat slower speeds provide greater range, but reduced capability for successful airstarts. There is sufficient engine rpm for adequate hydraulic pressure to approximately 10,000 feet.

WARNING

Landing with both engines inoperative should not be attempted.

ENGINE SHUTDOWN

Engine shutdown should be accomplished in the event of complete engine failure such as seizure or explosion, or in the event of mechanical failure within the engine or engine accessories in order to avoid or delay complete engine failure. Mechanical failure situations include uncontrollable oil temperature, EGT, or rpm, and abnormal oil pressure, fuel flow, or vibration. Complete failure probably will not permit normal windmilling operation but, if the engine continues to rotate, cooling fuel will circulate through the engine and aircraft cooling loops with the throttle OFF. An airstart should not be attempted since doing so can result in fire or explosion. Normal windmilling speeds can be expected after shutdown for mechanical failure and fuel cooling will continue unless the fuel is shut off. In some cases, airstart may be attempted after mechanical failure when conditions are favorable for control of oil temperature or pressure or EGT.

WARNING

Positively identify the failed engine before employing the engine shutdown procedure.

If engine shutdown is necessary:

1. AFT BYPASS SWITCH - OPEN.

   For the affected engine, select the OPEN position of the inlet aft bypass switch in order to delay onset of roughness or inlet unstart when the engine is shut down.

2. THROTTLE - OFF.

   As the throttle is retarded, pause momentarily at the Military and Idle positions.

3. RESTART SWITCH - ON (in roughness).

   Set the Restart switch for the affected engine inlet ON when roughness encountered.

   This causes the forward bypass to open and the spike to move forward. Roughness will be encountered at approximately Mach 2.4 and may persist to low supersonic speed. If an engine is shut down at subsonic speed, setting the Restart switch ON only opens the forward bypass as the spike is already forward.

4. Generator switch (affected engine) - OFF.

   Setting the generator switch OFF before the automatic cutout feature operates avoids the possiblity of electrical transients which might affect the navigation system.

5. Emer fuel shutoff switch - Fuel off if necessary.

   Fuel shutoff stops flow through one fuel cooling loop system. Depending on existing circumstances, this step may not be desirable or necessary.

WARNING

Shutting off fuel to a windmilling engine while at high Mach numbers may cause additional emergencies due to loss of cooling fuel for the engine and aircraft systems.

If left engine shutdown:

6. Cockpit air switch - EMER.

7. Hydraulic system - Review SAS and hydraulic services available.

   Refer to procedures for SAS, flight control system, and hydraulic system emergencies for operating procedures.

8. Control c. g.

   Refer to use of forward transfer and crossfeed as described under fuel system emergency operating procedures to control c. g. during single engine operation.

9. Land as soon as possible.

SINGLE ENGINE FLIGHT CHARACTERISTICS

The aircraft design is such that no flight system is dependent on a specific engine; therefore, the loss of an engine will not result in subsequent loss of all hydraulic or electrical systems. If an engine fails at low speed just after takeoff, the large amount of asymmetric thrust may require bank toward the good engine and full rudder for directional control. Refer to figure 3-3 for minimum single engine control speeds. After regaining control, however, 7° to 9° rudder trim with bank and sideslip toward the good engine provide minimum drag during acceleration to climb-out speed. Charts showing single engine climbout capabilities are included in the performance data appendix. Acceleration to climb speed and climb to landing pattern altitude can be accomplished with Maximum thrust on the operating engine when a climb capability exists for the operating condition. During single engine cruise, or after climbout, reduction to zero rudder trim and use of bank and sideslip to maintain course provides minimum drag. Up to 10° bank toward the good engine may be required.

Pitch trim changes can be expected while dumping fuel due to shifting center of gravity as the tanks empty. Directional trim is quite sensitive to changes in airspeed and power settings during landing pattern operation.

At high speed, engine failure or engine flameout could cause yaw angle to become critical at high rates if an effective damper were not operating. Temporary thrust reduction on the good engine helps to counteract the asymmetric thrust condition. Follow-up rudder action is necessary. If large yaw angles develop, inlet duct airflow disturbances may cause the other engine to stall or flame out.

Roughness, if encountered, is more intense with increasing KEAS and Mach number. The maximum structural loads imposed are severe, but are well below design limits.

If airstart attempts are unsuccessful, or if engine failure has occurred, a descent to intermediate altitudes will be necessary. The spike should be forward and bypass doors open on the windmilling engine to delay onset of roughness. Note the effect of Mach number and engine rpm on inlet roughness as shown by the Inlet Unstart Boundaries chart, figure 3-5. Descent range can be extended by decelerating with minimum afterburning or Military thrust on the good engine. Base the choice on the power condition to be used for single engine cruise. When no airstart is to be attempted, decelerate at 300 KEAS until subsonic cruise altitude is reached. A bank of up to 10 degrees with zero rudder trim should be used to achieve best cruise performance.

Fuel management during protracted engine out operation should be directed toward maintaining optimum center of gravity conditions, making all of the fuel available to the operating engine and, when possible, continuing the fuel cooling of necessary systems. Improper c. g. conditions will be indicated by abnormal pitch trim requirements.

Single-Engine Air Refueling

Single engine air refueling may be accomplished using either normal or alternate refueling procedures. Approximately the same control trim and forces as for single engine cruise may be used with bank angles up to 10°. Afterburning on the operative engine will be necessary when near 30,000 feet at normal refueling speed, and a toboggan may be necessary after approximately 15,000 pounds of fuel are on board. Refuel hook-up may be accomplished with the operative engine near Military power at low altitudes, although lack of excess thrust will make the hook-up more difficult and a continued descent may be necessary as fuel is onloaded.

NOTE

- Trimming EGT up toward limit values improves refueling altitude capability.
- If the left engine or the left hydraulic system is inoperative, right hydraulic pressure may be used by placing the brake switch in the ALT STEER & BRAKE position.
- When using minimum afterburner at intermediate altitudes or with small quantities of fuel remaining, it may be necessary to hook-up while climbing in order to avoid overrunning the tanker.

SINGLE ENGINE CRUISE

Minimum A/B thrust and Military thrust provides the best levels of single engine cruise performance. Military provides the best range performance, but penalizes the aircraft in altitude capability especially at heavy gross weights. Minimum A/B provides good range performance with an ample altitude capability. The Maximum A/B single engine cruise has poor range performance and should be only used in cases where the required cruise altitude is higher than the minimum A/B cruise capability.

Since hot temperatures adversely effect aircraft ceiling, an altitude capability lower than shown on the charts must be expected on a Hot Day.

Refer to Appendix Part IV for single engine cruise performance.

AFTERBURNER FLAMEOUT

Afterburner flameout can be expected as a result of engine stall or abnormal inlet operation, or insufficient airspeed at altitude. Afterburner flameout may be detected by a loss of thrust and by comparison of nozzle position indicators. The flamed-out afterburner nozzle will be noticeably more closed. Fuel will continue to flow from the spray bars until the throttle is retarded to MILITARY. Correct the inlet, engine, or airspeed and altitude condition before attempting afterburner relight. At high Mach numbers, the minimum airspeed necessary for afterburner operation is lower with automatic scheduling than with spike forward.

In the event of afterburner flameout, attempt to relight as follows:

1. Throttle - Retard to Military.
2. Throttle - A/B midrange.

   Note TEB shot counter number and fuel flow increase.
3. Nozzle position - Check.

   Check for more open nozzle position.

If relight not successful:

4. EGT - Increase trim.

   For CIT above 5°C, trim toward 805°C EGT.

   For CIT below 5°C, trim toward 825° to 845°C EGT range.

   CAUTION

   Uptrim to the 825° - 845°C EGT range carefully due to possibility of engine surge.

If relight by catalytic igniters not successful:

5. Igniter purge switch - On for two seconds.

   CAUTION

   The TEB supply will be depleted rapidly if the igniter purge switch is held on for more than two seconds.

If relight not successful:

6. Throttle - Military.

AFTERBURNER CUTOFF FAILURE

If the afterburner does not cut off when the throttle is retarded to Military, an attempt can be made to vary the thrust by retarding the throttle below Military. The engine should be shut down if thrust cannot be modulated satisfactorily. The fuel may have to be shut off if the flowmeter indicates that the afterburner is dumping fuel.

AFTERBURNER NOZZLE FAILURE

Nozzle malfunctions may be indicated by the nozzle position indicator, excessive rpm fluctuations, or failure of the engine to control to schedule speed. This may be accompanied by compressor stall and exhaust gas overtemperature. Precautionary engine shut down may be necessary.

A nozzle failed open condition will be more difficult to recognize at high altitude during afterburner operation near limit KEAS because open nozzle position is normal in these conditions. As altitude increases and KEAS decreases, the nozzle gradually closes to 60 to 80% open as limit altitude is approached. A failed open nozzle will result in abnormally high engine speeds under these conditions. An increase in afterburning throttle position or a reduction in cruise altitude while maintaining cruise Mach number (increasing KEAS) may permit cruise to be continued until the scheduled descent point is reached. Nozzle position and rpm of the normally operating engine can be used as a guide in selection of the lower cruise altitude range where an open nozzle position is normal. Be prepared to use less than Military throttle when the afterburner is shut down.

At intermediate altitudes, the nozzle failed open condition may be recognized by reduction of thrust and an increase in rpm. At low altitude and Mach number it will be necessary to rapidly retard the throttle to a point midway between IDLE and MILITARY to keep rpm within limits. The same procedure will apply when altitude and Mach number are decreased and the nozzle failure is detected. If the thrust requirement is critical, such as for takeoff, it may be practical to retain Maximum thrust, even with engine overspeed, until safe airspeed and altitude are attained.

A nozzle-closed failure can, in most cases, be detected by referring to the nozzle position indicator on the instrument panel and by analyzing engine symptoms. There are no obvious symptoms of a nozzle failed closed without afterburning because the nozzle is already closed, or nearly so, at Military thrust. EGT and rpm may fluctuate together. Either down trim the engine or retard the throttle slightly and check for rpm suppression or ENP change. A normally functioning nozzle will open slightly to maintain engine rpm. In the case of the nozzle failing closed, do not attempt to light the afterburner because the engine may flame out (after which it cannot be restarted due to reduced rpm). If the nozzle fails closed with afterburning, rpm suppression will occur, probably unstarting the inlet shock wave. Compressor stall and afterburner flame out are extremely likely and EGT will probably rise.

Nozzle Failed During Cruise

When a reduction in thrust or rpm is desirable or nozzle failed closed:

1. Throttle - MILITARY or below, as required.
2. RPM and EGT - Maintain in limits.
3. Land as soon as practicable.

OIL PRESSURE ABNORMAL

Low Oil Pressure

A low oil pressure generally indicates an oil system malfunction. If the malfunction causes oil starvation of the engine bearings, the result will be a progressive bearing failure, loss of oil, and subsequent engine seizure. Bearing failure due to oil starvation is generally characterized by rapidly increasing vibration. If this occurs in conjunction with gage indication of pressure loss, reduce Mach number and altitude and do the following:

1. Throttle - OFF.
2. Land as soon as practicable.

High Oil Pressure

High oil pressure does not necessarily indicate a hazardous engine operation condition unless accompanied by high oil temperature; however, the high pressure condition must be reported after flight and the landing should be accomplished as soon as practicable.

OIL TEMPERATURE ABNORMAL

Abnormal high or low oil temperature is indicated by illumination of the OIL TEMP warning light. It is unlikely that low oil temperature will occur in flight with the engine operating, and a high oil temperature should be assumed. Abnormally high oil temperature could be caused by deficient lubrication flow or insufficient fuel/oil cooling. Abnormally low oil temp may be indicated before start or after extended windmilling operation at subsonic speeds. In the event of an L or R OIL TEMP warning light illumination in flight, proceed as follows:

1. Oil pressure - Check for normal indication.
2. Speed and altitude - Reduce as required if at high Mach number.
3. Fuel flow - Maintain over 12,000 pph (if practicable).

If temperature can not be controlled:

4. Throttle - OFF.
5. Land as soon as possible.

NOTE

If L or R OIL TEMP warning light illuminates after extended windmilling operation, refer to AIRSTART procedure, this section.

FUEL CONTROL FAILURE

If a fuel control malfunction is suspected, minimize throttle movements and monitor rpm and EGT closely.

FUEL-HYDRAULIC SYSTEM FAILURE

Fuel hydraulic system failure may be caused by a failed pump or a broken line or connector. A failed pump is indicated by inoperative exhaust nozzle and start and bypass bleed valves. Line failure is indicated by excessive fuel flow.

If engine fuel-hydraulic system failure is suspected:

1. Fuel flow - Check.

If fuel flow is excessive:

2. Throttle - Military.

CAUTION

Overspeed may occur.

3. ENP and rpm - Check.

If exhaust nozzle position indicator does not reflect a more closed position:

4. Throttle - Between Idle and Military.
5. Fuel flow - Check.

   A fuel flow of approximately 8000 to 9000 pph above normal will confirm a broken line.

When below Mach 1.7:

6. Throttle - OFF.
7. Emergency Fuel Shutoff switch - Fuel off.

FUEL SYSTEM

FUEL QUANTITY LOW WARNING

If the fuel quantity low warning light comes on with appreciably more than 5000 pounds of fuel indicated remaining in tank 4, determine total fuel from the individual tank quantities. Monitor tank 4 quantity and land as soon as practicable. Quantity indications are affected by pitch attitude and longitudinal acceleration. Total quantity indication is also affected by the fuel distribution in the individual tanks.

If the fuel quantity low warning light does not come on with less than 5000 pounds of fuel indicated in tank 4, test warning light and land as soon as possible.

FUEL PRESSURE LOW

If one or both FUEL PRESS LOW warning lights illuminate:

1. CROSSFEED - PRESS ON.
2. Tanks containing fuel - Press on.
3. Analyze difficulty and attempt to restore normal sequencing. The difficulty may be due to low rpm while transfering or dumping.

When fuel pressure is restored:

4. Crossfeed - Press off.

If pressure cannot be restored:

5. Land as soon as possible.

FUEL TANK PRESSURIZATION FAILURE

Fuel tank pressurization failure is indicated by the tank pressure gage and illumination of the TANK PRESSURE LOW warning light. It may be confirmed by liquid nitrogen quantity remaining gage indications. Impending failure is indicated by illumination of the N QTY LOW warning light.

No corrective action is possible after both liquid nitrogen systems are depleted except to limit rates of descent to minimize the difference between fuel tank and ambient pressures. In descent, the fuel tank suction relief valve in the nose wheel well opens when slightly negative tank pressures occur. Rates of descent should be limited so that tank pressure does not become less than -1/2 psi.

WARNING

Limit tank pressure is -1/2 psi. This limit is based on structural capabilities of the fuselage tanks.

To descend:

1. Descend so that minimum tank pressure limit is not exceeded.

   Adjust power and airspeed as required.

If flight included cruise over Mach 2.6:

2. Loiter at subsonic long range speed for 10 minutes if possible.

If loiter not possible:

3. Descend from FL 400 to FL 350 as slowly as possible.

4. Continue descent so that minimum tank pressure limit is not exceeded.

NOTE

Cooling will be accelerated and pressure may be relieved faster after reaching subsonic speeds if the nose gear is extended.

FUEL BOOST PUMP FAILURE

Loss of all boost pumps can only result from multiple failures. It would be indicated by illumination of both fuel pressure low lights.

WARNING

Fuel cannot be dumped with complete boost pump failure. Use caution if heavyweight landing is required.

Partial boost pump failure may not be indicated by the fuel pressure low lights. Incorrect fuel sequencing and center-of-gravity shift may be the first indication. Proceed as directed for Fuel Sequencing Incorrect. Crossfeed may be required; however, when crossfeed is on, more fuel will tend to feed from the forward tanks which have boost pumps operating. This could cause an aft c. g. shift which might be hazardous when operating with a failed pitch SAS.

FUEL SEQUENCING INCORRECT

Incorrect automatic fuel sequencing is indicated primarily by the fuel boost pump lights. (A light may illuminate out of norma sequence, or fail to illuminate on schedule.) In this event, control the boost pumps manually until correct automatic sequencing resumes or a landing is made. It is possible that faulty fuel sequencing may manifest itself by secondary indications, such as a fue low level light coming on prematurely, or an abnormal adjustment required in pitch trim due to c. g. change by faulty fuel distribution. Note that forward c. g. requires increased power to maintain speed and altitude. If normal sequencing does not resume and manual sequencing is either inconvenien or impossible, turn crossfeed on or transfe fuel to ensure that any available fuel will ge to the engines.

CAUTION

Do not permit a manually selected fuel boost pump to continue running in an empty fuel tank. The boost pump will be damaged.

NOTE

Crossfeed may be required to provide fuel to both engines during fuel sequence malfunctions.

Fuel System Management With Engine Shutdown

During single engine operation with the left engine failed, the crossfeed valve should be opened after tanks 5 and 6 are emptied by right engine consumption. If the right engine has failed, empty tanks 5 and 6 by successive forward transfer operations. This accomplishes the dual purpose of maintaining c. g. and using all available fuel.

NOTE

Fuel transfer capability is lost when operating on battery power and the crossfeed valve position cannot be changed. An aft c.g. shift can be expected as fuel is consumed.

Fuel cooling is continued automatically when the inoperative engine is windmilling unless its emergency fuel shutoff switch is actuated.

Crossfeed should never be used during forward transfer when fuel remains in tanks 5 or 6. If it were, most of the fuel transferred would come from the operating tank(s) of group 2, 3, or 4 because of the aircraft nose up attitude and lower fuel pressure head these pumps would have to overcome. Only a small forward c.g. shift would result.

EMERGENCY FUEL OPERATION

The design and specification operating envelope of the JT11D-20 engine necessitates operation with a fuel having special characteristics. During high Mach number operation the fuel serves not only as the source of energy but is used in the engine hydraulic system and serves also as a heat sink for cooling the various aircraft and engine accessories heated by the high ambient air temperatures. This requires a fuel having high thermal stability so that it will not break down and deposit coke and varnishes in the fuel system passages. A high luminometer number (brightness of flame) is required to minimize transfer of heat to the burner parts. Other items are also significant, such as the amount of sulphur impurities tolerated. An advanced fuel, PWA 523E, was developed to meet the above requirements.

In addition to the fuel requirements, a special lubricity additive is used with PWA 523E to insure adequate lubrication of fuel and hydraulic pumps.

Fuels such as JP-4, JP-5, and JP-6 may be used only for emergency requirements such as air refueling when standard fuel is not available and air refueling must be accomplished or risk loss of the aircraft. Air refueling procedures with JP fuel are the same as for the approved fuel.

When these JP fuels are used, operation should be restricted to a maximum speed of Mach 1.5.

ELECTRICAL POWER SYSTEM FAILURE

SINGLE AC GENERATOR FAILURE

Failure of one ac generator will be indicated by illumination of the warning light. One generator in normal operation is sufficient to support the entire electrical load. In the event of generator failure, proceed as follows:

1. Generator switch - RESET then release.

If the generator fault has been corrected, the generator will be reconnected to the system and the warning light will go out.

If the light remains on:

2. Failed generator switch - TRIP.

3. Land as soon as practicable.

If flight is continued with an inoperative engine or generator:

Note

Depending on flight conditions and prior to a possible failure of the other generator - forward transfer may be advisable.

4. Affected generator - TRIP.

If [ ] equipment is operating:

5. TACAN - OFF.

CAUTION

- Do not manually select additional fuel tank pumps.
- HF radio transmissions are limited to one minute of any ten minute period.

DOUBLE AC GENERATOR FAILURE

If both ac generators fail the ac buses and the dc monitored bus will be dead. All equipment normally powered from the ac generator buses will be inoperative including the fuel tank boost pumps which will prevent dumping and forward transfer. Manual pitch yaw and roll trim and EGT trim will also be inoperative. Instrument and panel lights and landing and taxi lights will be inoperative but cockpit lighting will be available from the cockpit spot and floodlights. Q-bay equipment will be inoperative. The INS requires considerable electronic power and should be turned off unless essential for navigation. The autopilot and attitude selector switch should be placed in the FRS position. All engine and airplane instruments and annunciator panel indicators will be available except the standby attitude indicator and compressor inlet pressure indicator.

All other ac and dc equipment will be powered by the two emergency batteries but for maximum operating time of approximately twenty five minutes the No. 2 and No. 3 inverters must be turned off. This will deactivate the SAS B, monitor channels and INS. The SAS A channel and most engine and aircraft instruments will be powered by the No. 1 inverter with the No. 4 inverter available for backup.

For maximum effective operating time of at least 25 minutes the following equipment should be turned off by the individual equipment switch.

UHF, HF, TACAN, and ADF Radio

No. 2 and No. 3 Inverters

INS

Q-bay Equipment

Autopilot and SAS B & M Channels

Anti-collision Lights

[ ] and X-band Beacon

[ ] Equipment

After 25 minutes various relays may begin to "drop out" and at approximately 40 minutes the No. 1 inverter will deactivate. The A SAS channel and most electrical engine and aircraft instruments will become inoperative. The ARC 50 inverter will continue to operate at a reduced rate and ultimately deplete the battery.

When subsonic the inlet control and bypass circuit breakers should also be pulled.

1. Battery switch - Check BAT.
2. Generator switches - RESET.
3. If only one generator resets - Land as soon as practicable.
4. If neither generator resets - Conserve batteries.
5. Land as soon as possible.

AC GENERATOR UNDERSPEED

The minimum windmill speed at which the ac generators will supply power is approximately 2800 rpm. If the left engine is below approx 4500 rpm the HF radio will be inoperative. The left generator may be tripped to restore operation if the right engine is above 4500 rpm.

TRANSFORMER RECTIFIER FAILURE

One transformer rectifier will supply the normal electrical demands. Variable frequency ac power systems will continue to operate normally. A double failure of the transformer rectifiers removes power from the dc monitored bus but the INS will be op-

erated from the INS battery and No. 3 inverter. The batteries will operate the dc essential bus and should be managed as for double generator failure.

INVERTER FAILURE

The inverter powered systems operate from separate inverters. Refer to Electrical Power Distribution diagram, Section I. No. 1 inverter is the most important with No. 2 and No. 3 following in order of lesser importance. The No. 4 inverter is installed to serve as a backup in the event of failure of any one inverter. It is placed in operation by turning the failed inverter switch to the EMER position. If a second inverter failure should occur the No. 4 inverter will power the lowest numbered inverter bus whose switch is in the EMER position.

If an inverter failure is indicated by illumination of an INVERTER OUT warning light, proceed as follows:

1. Failed inverter switch - EMER.

Check that INVERTER OUT light extinguishes:

2. Illuminated SAS recycle lights - Press.

HYDRAULIC POWER SYSTEM FAILURE

With both engines out, the hydraulic pumps provide sufficient flow for satisfactory flight control system operation at windmill speeds above 3000 rpm. Reduced control system capability is available down to a windmilling speed of approximately 1500 rpm. With one engine windmilling, all primary and most utility services are supplied by the operating engine hydraulic systems. The windmilling engine utility system pressure and flow may be sufficient to supply service until the engine is almost stopped.

PRIMARY HYDRAULIC SYSTEM FAILURE

The loss of either A or B hydraulic system will be indicated by the warning light on the pilot's center console, the master caution light, and the dual A and B hydraulic pressure gage. Reduce speed to less than 350 KEAS if either A or B system fails and turn Reserve Hydraulic Oil System switch on to the operative system (A or B). This will ensure a minimum of at least 3 hours of flight control time remaining at high speed cruise schedules.

Disengagement of the failed hydraulic system SAS channels is necessary to maintain full yaw and roll damping capability. As a hydraulic system failure is not sensed by the SAS equipment, it is necessary to double the SAS signal gain of the operating channel to give the equivalent control response in yaw and roll. Airspeed reduction with a single hydraulic system is a precautionary procedure which allows for the reduction in available hinge moment capability. Disengagement of the failed system SAS pitch channel is not mandatory, but it may be more desirable to disengage all three channels than only the yaw and roll switches. Monitor all system operations closely and attempt to determine if a complete failure is imminent. Be prepared for ejection prior to complete failure.

UTILITY HYDRAULIC SYSTEM FAILURE

The loss of L or R hydraulic system will be indicated by the dual L and R hydraulic pressure gage. If the pressure of the L system falls below 2000-2200 psi, crossover for gear retraction is automatic. The manual release must be used to lower the gear. Items which are affected by the L hydraulic system are normal brakes, nosewheel steering, aerial refueling system and the left inlet control actuators. Items which are affected by the R hydraulic system are right inlet control actuators, alternate steer and brakes and air refueling system.

FLIGHT CONTROL SYSTEM FAILURE

With both engines out, the ac generators furnish rated electrical power at windmill speeds above 2800 rpm. The emergency batteries provide SAS operation at lower windmill speeds. There is sufficient hydraulic flow to operate the control surfaces at satisfactory rates above 3000 rpm and operation at reduced rates is available to a windmilling speed of approximately 1500 rpm.

NOTE

During single engine operation, a windmilling engine may not develop sufficient system hydraulic pressure to maintain operation of its associated SAS servo channels. To avoid nuisance disengagement of SAS channels, turn off all three SAS channel switches for the windmilling engine hydraulic system when lower than normal pressure is indicated. Pitch and Yaw SAS damping will continue on one channel. The operative engine SAS roll channel must be cycled OFF then ON to maintain damping in the Roll axis.

FLIGHT CONTROL SYSTEM EMERGENCY OPERATION

If either the A or B hydraulic system fails, the control forces will not change. Either system will operate the control surfaces, but at a slower rate and with some reduction in control responsiveness at high KEAS and Mach numbers.

If control difficulties are encountered:

1. Check A and B hydraulic system pressures. If either A or B hydraulic system has failed proceed as directed for A or B hydraulic system failure this section.
2. Disengage autopilot and check control.
3. Check SAS warning lights. If SAS failure has occurred, proceed as directed under SAS Emergency Operation this section.

A OR B HYDRAULIC SYSTEM FAILURE

1. Reduce speed to less than 350 KEAS.

CAUTION

Do not exceed 350 KEAS with either an A or B hydraulic system inoperative. If either system fails above this speed, reduce speed as soon as possible. Flight control responsiveness will be reduced during single hydraulic system operation at high KEAS and Mach numbers, and flight maneuvers under these conditions should be held to a minimum.

2. Affected SAS yaw and pitch switches - OFF.
3. SAS roll switches - OFF.
4. Operative roll channel switch - ON.

NOTE

When one roll SAS channel is disengaged or turned off the simplified logic circuit will disengage the other roll channel. The desired roll channel switch must be turned OFF and then re-engaged to regain single channel roll SAS operation.

5. Reserve hydraulic oil switch - To operative system (A or B).

BOTH A & B HYDRAULIC SYSTEMS FAILED

1. EJECT.

WARNING

If both the A and B hydraulic systems have failed all flight controls will be inoperative.

SAS EMERGENCY OPERATION

SAS emergency operating procedures and the applicable flight limitations should be used whenever there has been a channel disengagement or a reduction in SAS effectiveness. Disengagement may result from failures of any of the following systems or components: SAS gyro or electronics circuitry, flight control servos, or electrical power supply. Disengagement or loss of effectiveness may occur as a result of complete or partial loss of A or B System hydraulic power. Disengagement of any channel is indicated by illumination of the master caution light, the SAS CHANNEL OUT light on the annunciator panel, and one or more of the recycle indicator lights on the SAS control panel.

MINIMUM AIRSPEED LIMITS WITH PITCH SAS INOPERATIVE

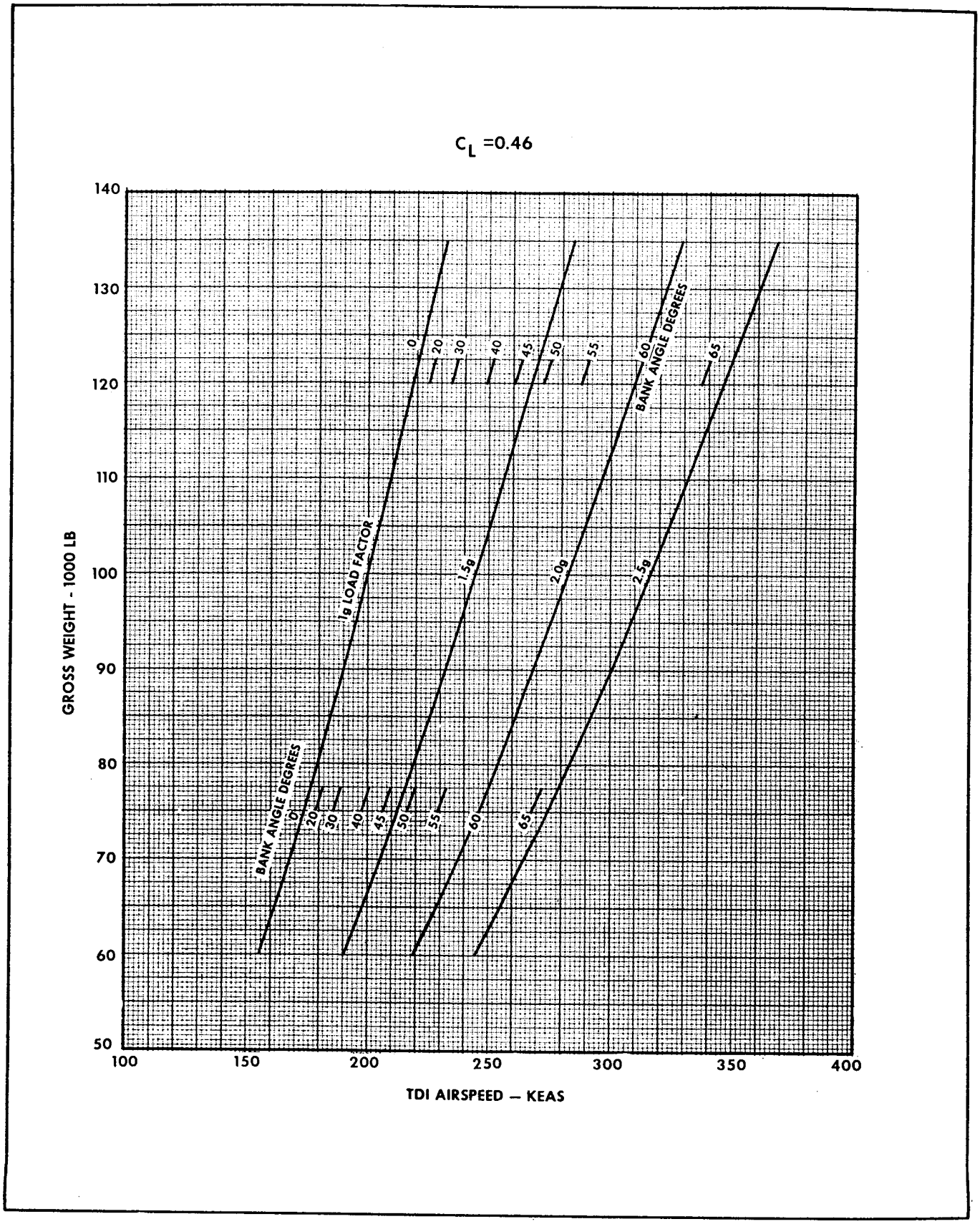


Figure 3-7

When a malfunction is indicated in any SAS axis, initiate the following preliminary actions:

a. A & B hydraulic system pressures - Check normal. If hydraulic system failure is indicated, follow A and/or B Hydraulic System Failure procedure, this section.

b. INVERTER OUT Warning Lights - Check.

   If illuminated, use Inverter Failure procedure, this section.

c. Proceed to appropriate Pitch and Yaw axis or Roll Axis Failure procedures, this section.

A single failure or sequence of failures in the pitch and yaw axes which leaves one A or B channel operating in each of these axes does not change the aircraft flight characteristics. However, some undesirable cross-coupling in the pitch and yaw axes may result from failure of one roll channel. Characteristics which change as a result of failures affecting both the A and B channel servos in an axis are described as second condition failures with the appropriate procedures. Also refer to the SAS Warning Lights charts, Figure 3-8, which illustrate the probable causes of failure indications, remaining capabilities, procedures, and limits which apply after channel disengagement.

Pitch and Yaw Axis Failures

A "first" condition failure exists after attempts to extinguish one or more recycle lights are ineffective and either an A or B channel is operating (light Off) in each of the pitch and yaw axes. A "first" condition failure exists with a single A, B, or M channel light illuminated or in some cases after simultaneous or progressive illumination of two or more of these lights, as illustrated by the SAS Warning Lights Chart, Figure 3-8, Sheets 1 and 2.

NOTE

Consider that no failure exits when all pitch and yaw recycle lights have been extinguished, regardless of previous combinations of illumination, if normal operation of the recycle lights is verified by depressing the SAS Lights Test button.

Flight may be continued without restriction when a first condition failure exists except that maximum airspeed is limited to 350 KEAS in the case of combined channel failures due to low hydraulic system pressure.

A "second" condition failure is defined as existing whenever the A and B recycle lights in one axis remain illuminated after attempts to extinguish them are ineffective. When a "second" condition failure exists, flight speed is restricted to Mach 2.8 and 350 KEAS. Transfer fuel as required to obtain either 2° nose up trim or 4000 pounds in tank 1.

NOTE

Each instance of recycle light illumination presents a new situation and, if the light(s) can not be extinguished, the condition must be determined as being a "first" or "second" condition of failure in accordance with the definitions provided above.

Logic override procedures are usable after a "second" condition failure when the sequence of light illumination indicates that a channel with operative servos is available. Refer to After Second Failures, SAS Warning Lights Chart. When use of logic override is effective, flight characteristics are the same as with SAS fully operational. However as a precaution against subsequent hardover failures signals, the autopilot must not be engaged in that channel and second condition failure limits apply.

WARNING

If logic override is recommended, use it only in the channels specified and only after decelerating to second condition failure limit speeds in order to prevent excessive structural loads which could result from a hardover failure at higher speeds.

Neither logic override nor BUPD operation should be attempted with either channel known to have a failed servo.

BUPD plus logic override procedures are available after a "second" condition failure in the pitch axis. The BUPD is optimized for operation at air refueling speeds, and it should not be operated above 330 KEAS or 0.85 Mach. It may or may not improve flight characteristics at other flight conditions.

Logic override or BUPD plus logic override may not be usable or effective after a second condition failure in the pitch axis. If neither can be employed, some longitudinal overcontrol probably will occur when at high Mach numbers. Observance of second failure limits is required, and descent to subsonic operating speeds is recommended when practicable. Air refueling and landing may present some difficulties in maintaining precise attitude control. With pitch SAS off and neutral c.g. there is no tendency for the aircraft to return to a trimmed attitude when a displacement occurs at landing pattern speeds. However, divergent speed and attitude tendencies occur slowly enough to be completely controllable. Minimum airspeed limits with pitch SAS inoperative (Figure 3-7) should be observed.

If logic override procedures are not effective or possible after a second condition failure in the yaw axis, tests at high Mach numbers indicate that neutral to slightly positive stability exists but that there is little damping of yaw oscillations after they commence. Automatic scheduling of the inlet components may induce neutrally damped directional oscillations while above Mach 2.8. Directional and roll control could become difficult in the event of an unstart or flameout while above Mach 2.9 as a result of large bank angles generated by yawing motion. Pilot rudder inputs usually tend to aggravate this condition. These conditions could also result in excessive rudder surface loads at airspeeds above 400 KEAS. Use of both restart switches is recommended while decelerating in order to avoid asymmetric nacelle drag conditions or unstarts.

1. Illuminated recycle light(s) - Depress and release.

If light stays on or reilluminates:

2. Channel switch - OFF.

   No further action is required unless a 2nd condition failure exists.

If another failure should occur in the same axis:

3. Illuminated recycle light(s) - Depress and release.

4. If lights do not extinguish - Comply with limits.

For second condition failure above Mach 2.8 or 350 KEAS:

5. Restart switches - ON (simultaneously) except during climb.

NOTE

If climbing, bleed speed below 350 KEAS.

6. Throttles - Minimum A/B.

SAS WARNING LIGHTS CHART

PITCH OR YAW RECYCLE LIGHTS ON

INDICATIONS AFTER FIRST FAILURE

PITCH OR YAW Light(s) on (1st / 2nd)									
A	●	○	○	●	○	●	○	2	○
B	○	●	○	○	●	○	●	○	2
M	○	○	●	●	●	2	2	●	●
SEQUENCE OF ILLUMINATION — FIRST	A servo	B servo	M gyro	A gyro	B gyro	A servo	B servo	M gyro	M gyro
SEQUENCE OF ILLUMINATION — SECOND						M or A gyro	M or B gyro	A servo	B servo
CHANNELS REMAINING OPERABLE	B	A	A and B	B	A	B	A	B	A

ACTION: First try to press light(s) off — then ➡ No further action when first failure lights stay on A or B light is off

LIMITS: NONE

INDICATIONS AFTER SECOND FAILURE

PITCH OR YAW (1st / 2nd)								
A	2	●	2	●	2	●	2
B	2	2	●	2	●	2	●
M	●	●	●	2	2	○	○
SEQUENCE OF ILLUMINATION — FIRST	M gyro	A gyro	B gyro	A servo	B servo	A servo	B servo
SEQUENCE OF ILLUMINATION — SECOND	A or B gyro	B or M gyro or B servo	A or M gyro or A servo	B gyro	A gyro	B servo	A servo
FUNCTIONS OPERABLE	A or B Channel	A servo's possibly B channel	B servo possibly A channel	B servo	A servo	NONE	

ACTION

First try to press lights off — then ➡

If A and B lights stay on:

- pitch or yaw: Try Override
  - A or B first: A | B | A
  - Unless subsonic then BUPD plus pitch override: A | B
- If pitch Try BUPD plus override: B | A
  - If Yaw No Action
  - NO ACTION
  - UNUSABLE pitch or yaw SAS

To use pitch or yaw Logic Override:
A and B Channels off. Select A or B override.
Beep Channel switch ON.
To use BUPD:
A and B channels OFF. BUPD - ON
Select A or B Override. Beep one Channel on.
Channel off if no improvement.

Do not use Logic Override or BUPD

Note: Use of Logic Override is not mandatory

LIMITS

Mach 2.8 and 350 KEAS maximum.
Fuel transfer is necessary for 2° noseup trim up to 4000 lb.
With override - No autopilot that axis
With BUPD - Mach 0.85 and 330 KEAS

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Figure 3-8 (Sheet 1 of 2)

SAS WARNING LIGHTS CHART

COMBINATIONS OF PITCH, ROLL AND YAW DISENGAGE LIGHTS
INVERTER OUT AND A OR B HYDRAULIC LOW
WARNING LIGHTS ON

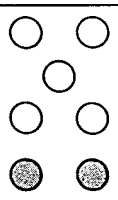
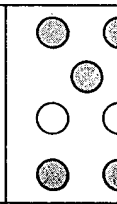
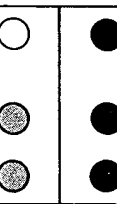
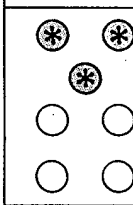
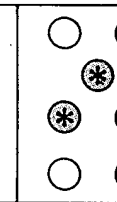
INDICATION	ELECTRICAL FAILURE				HYDRAULIC FAILURE		
PITCH YAW A A ROLL B B M M							No lights on but operation poor
CHECK	INV 3	INV 1	INV 2	ANY TWO	A System	B System	BOTH A and B
ACTION	1 Check circuit breakers a Inv 3 ØB-SAS pitch-yaw mon b Ess DC bus-SAS M 2 Inverter Switch - EMER 3 Press recycle lights off 4 Recycle roll channel switch if light is on 5 Do not use logic override	1 Check circuit breakers a Inv 1 ØB-SAS yaw A b Ess DC bus-SAS A	1 Check circuit breakers a Inv 2 ØB-SAS yaw B b Ess DC bus-SAS B	1 Check circuit breakers a Inv 1, 2, 3 b Ess DC bus-SAS A, B, M Note: M Channels will be inoperative	Channel off if pressure is low With normal pressure: 1 Cycle roll channel switch 2 Press recycle lights off Note: Any combination of A, B, and/or roll lights may occur Lights may illuminate simultaneously or progressively		
LIMITS	NONE			2nd Failure	350 KEAS maximum		

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Figure 3-8 (Sheet 2 of 2)

When speed is stabilized below Mach 2.8 and 350 KEAS:

7. Restart switches - OFF.
8. Aft bypass switches - Normal schedule.
9. Throttles - As required.
10. Forward transfer switch - Transfer as required to maintain at least 2° nose up trim up to 4000 lb.

If SAS lights indicate a good servo is available:

11. A or B logic override - Engage as indicated by servo availability.
    a. Pitch or yaw logic override switch - A or B position depending on failure analysis.

NOTE

Refer to SAS Warning Light Chart.

    b. Appropriate A or B channel switch - Beep ON.

    Recycle light should extinguish.

    c. If control does not improve - Channel switch - OFF.
    d. Logic override switch - OFF.

For pitch axis second condition failure; when speed is below 330 KEAS and 0.85 Mach:

12. BUPD - Engage as required.

    a. Pitch SAS A and B channel switches - OFF.

    b. BUPD switch - ON.

    c. Pitch logic override switch - A or B position as indicated by servo availability.

    d. Appropriate A or B pitch SAS channel switch - Beep ON. Recycle light should extinguish.

    e. If control does not improve - Channel switch OFF.

    f. Logic override switch - OFF.

    g. BUPD switch - OFF.

    h. Depending on failure analysis this procedure may be repeated using other SAS channel if indicated.

Roll Axis Failures

Illumination of the roll channel disengage light shows that both roll channels and the roll autopilot are disengaged. When there is no apparent fault in the hydraulic systems or electrical power supply which would cause disengagement, check for a transient disengagement as follows:

1. A or B channel switch - OFF, then ON.

A transient or intermittent fault existed if the light then remains off. If the light does not extinguish, or reilluminates while maneuvering, a first condition failure exists in the roll mode.

For a first failure:

2. A and B channel switches - OFF.

Unless the failure can be associated with a specific hydraulic or electrical power supply, regain the use of one channel by the following arbitrary step sequence:

3. A channel switch - ON.

NOTE

Be prepared to move the switch to OFF immediately if a hardover signal results, indicating that the failed channel was inadvertently selected.

Operation with only one roll channel engaged results in overriding of logic circuitry. There is no automatic protection against inadvertent selection of a failed channel, or against subsequent failure of a properly operating channel which has been engaged.

If a hard-over signal is obtained on engagement or during subsequent operation, or if no improvement is noted in flight characteristics:

4. A channel switch - OFF.

5. B channel switch - ON.

NOTE

Be prepared to disengage the channel immediately if a hardover signal results.

If a hard-over signal is obtained on engagement or during subsequent operation, or if no improvement is noted in flight characteristics, a dual or second condition failure exists.

For a second condition failure:

6. Roll channel switches - Both OFF.

Some undesirable cross-coupling may occur during single roll SAS channel operation. This appears as small amplitude oscillations in the pitch and yaw axes, as the elevons on only one side of the aircraft respond to roll signals during single channel operation and compensation for the asymmetric roll signals is provided by pitch and yaw axis control operation.

Scheduled activity may be continued for the remainder of the flight with a single roll SAS channel operating. The roll autopilot may be engaged and the automatic navigation feature of the INS used as desired.

NOTE

- Operation with both roll channels disengaged is permitted if cross-coupling about the pitch and/or yaw axes prevents precise aircraft control with one roll channel engaged.

- In the event of single engine failure at low speed, or during single engine landing, failure of one roll SAS channel and simultaneous automatic disengagement of the other roll channel may occur due to loss of hydraulic power from the windmilling engine.

To avoid changes in control characteristics at a critical time during single engine landings, either make the approach with both roll SAS channels disengaged or with the roll channel which is powered by the inoperative engine disengaged.

A second roll SAS channel failure while at high speed will probably be indicated by abnormal pitch transients and small roll transients without illumination of either pitch or roll SAS indicator lights. The symptoms may be difficult to attribute to roll channel failure. When pitch transients occur with one roll channel engaged, disengage both roll SAS channels and check for control improvement. If no improvement is noted, the single roll channel may be reengaged if desired.

Failure or intentional disengagement of both roll SAS channels is expected to increase pilot fatigue, reduce mission effectiveness, and will disable the roll autopilot; however, no hazard to safety should result and there are no flight restrictions on continued operation.

TRIM FAILURES

Pitch, yaw or roll trim malfunctions may be of the inoperative type or the runaway type. Runaway trim failures in pitch may occur at slow speed (0.15°/sec change in elevon deflection) if due to automatic trim motor operation or at fast speed if due to manual trim motor operation (1.5°/sec change in elevon deflection). A low speed runaway type of malfunction will be apparent by the need for constant manual pitch trimming. The runaway yaw trim rate is approximately 1.5° per second trim change. The roll trim rate is approximately 1°/sec. Runaway yaw trim will be accompanied by rudder pedal deflections as the surfaces move. Runaway pitch or roll trim will not be accompanied by stick movement due to surface movement.

In the event trim runaway failure is suspected, proceed as follows:

1. TRIM POWER SWITCH - OFF.

If circumstances permit:

2. Reduce speed to below 350 KEAS and 2.5 Mach number.

With runaway nose up pitch trim:

3. Transfer fuel forward to reduce forward stick force requirement.

WARNING

Do not transfer fuel if nose down pitch trim has occurred.

When time and conditions permit:

4. Autopilot - ON. Check for control improvement.

5. Affected trim circuit breakers - Pull.

NOTE

Both A & C phase circuit breakers must be pulled on the suspected circuit.

Trim Malfunctions:

a. If runaway slow speed pitch trim - Pull auto pitch trim circuit breakers.

b. If runaway high speed pitch trim - Pull manual pitch trim circuit breakers.

c. If runaway roll or yaw trim - Pull roll or yaw circuit breakers.

6. Trim power switch - ON.

With manual pitch trim inoperative and auto trim available, engagement of the pitch autopilot will gradually correct an out of pitch trim condition. This will relieve the pilot of a need for maintaining stick deflection to maintain attitude. The pitch autopilot can also be used when the auto trim motor is inoperative, but automatic pitch trim synchronization will not be available.

CAUTION

Disengagement of the pitch autopilot when not in trim may be accompanied by a considerable transient.

If the trim malfunction is a runaway in the roll axis, right or left stick deflection will be required for the rest of the flight but stick force will not be more than normally required for the same amount of deflection. If the malfunction was a runaway in the yaw axis, rudder pedal force will be required to maintain neutral rudder pedal position.

AIR DATA COMPUTER FAILURE

If malfunction or failure of the air data computer (ADC) is suspected, proceed as follows:

1. Cross check TDI instrument against pitot-static operated airspeed and altimeter.

If cross check shows TDI to be inaccurate:

2. Revert to use of pitot-static operated instruments for aircraft control.

3. Autopilot - OFF.

PITOT-STATIC SYSTEM FAILURE

Under some conditions both of the pitot-static operated systems may become inaccurate or inoperative from a common malfunction. Failure of the pitot heater may simultaneously affect both normal sys-

tems in icing conditions. The pitot probe could be plugged by a foreign body of sufficient size. If both systems fail, proceed as follows:

1. Attempt to restore operation by selecting alternate static source.
2. Maintain aircraft control by use of attitude and power indicating instruments.
3. Request escort aircraft for letdown and landing.

AIR CONDITIONING AND PRESSURIZATION FAILURES

LEFT ENGINE OR COCKPIT SYSTEM INOPERATIVE

If the left engine is shut down:

1. Cockpit system switch - EMER.

COCKPIT DEPRESSURIZATION

Cockpit depressurization above approximately 35,000 feet will be indicated by pressure suit inflation. If suit inflates, proceed as follows:

1. Cockpit altitude - Check.

If increasing or at actual aircraft altitude:

2. Nose air - OFF.

CAUTION

When the nose air valve is OFF it will shut off pressurization and cooling air to the nose compartment and possibly result in loss of UHF, HF and IFF equipment. TACAN and normal ADF equipment located in the E-bay will still be available.

If cockpit altitude does not decrease:

3. Nose radio equipment UHF, HF and IFF - OFF.
4. Nose hatch seal lever - OFF.

NOTE

If cockpit repressurizes the pressurization loss is due to failure of the nose hatch seal and periodically the nose air and desired radio may be turned on for possible short time usage.

WARNING

During this time the pilot will be depending on the pressure suit only for altitude protection.

If cockpit still does not repressurize:

5. Nose air handle and nose hatch seal - ON.
6. Suit ventilation boost lever - EMERG.
7. Reduce altitude if possible.
8. Radio equipment - ON only as necessary after altitude is reduced.

COCKPIT AND VENTILATED SUIT ABNORMAL TEMPERATURE

1. Defog switch - OFF.
2. Cockpit temperature indicator - Check.

If temperature indication is abnormal:

3. Cockpit auto temperature rheostat - Rotate as desired.

NOTE

The temperature control bypass valves are motor operated and travel from full hot to full cold or vice versa in approximately 7 to 13 seconds.

If auto temperature control is not effective and cockpit temperature remains too high or low:

4. Cockpit temperature control switch - HOLD in COLD or WARM as desired.

NOTE

In this position the temperature control bypass valves take 7 to 13 seconds to travel from full hot to cold or the reverse.

If no correction in temperature occurs in 30 seconds:

5. Cockpit system switch - EMER.

If cockpit temperature is still abnormal:

6. Q-Bay or emer cockpit auto temperature rheostat - Rotate toward COLD or WARM as required.

If suit temperature cannot be controlled by the preceding steps:

7. Suit flow valves - OFF.

8. Reduce altitude and speed as required.

Q-BAY ABNORMAL TEMPERATURE

If the Q-BAY temperature indication is abnormal, proceed as follows:

1. Q-bay auto temp control - Rotate toward COLD or WARM as necessary.

NOTE

The above step should be accomplished in increments as there will be a lag in the temperature indication.

If auto temp control is not effective and Q-bay temperature remains abnormal:

2. Q-bay and cockpit EMERGENCY AIR switch - HOLD in COLD or WARM position as necessary.

NOTE

The temperature control valve will take from 7 to 13 seconds to travel from full hot to full cold or the reverse.

If Q-bay temperature control system should fail in the cold position and heavy cockpit fog occurs:

3. Q-bay system - OFF.

4. Normal cockpit air control - Rotate towards WARM as necessary to dissipate cockpit fog.

OXYGEN SYSTEM AND PERSONAL EQUIPMENT FAILURES

PRESSURE GAGE INDICATIONS

Rise of Pressure 100 to 120 psi range

1. System indicating normal pressure range - OFF.
2. Visor opening control - Depress 3-5 seconds. This allows increased oxygen flow between visor and seal.
3. System indicating normal pressure range - ON.
4. Repeat above steps if necessary.

If no correction noted:

5. It is safe to continue flight if pressure does not exceed 120 psi.

If pressure rises above 120 psi:

6. Malfunctioning system - OFF.
7. Land when practicable.

Drop of Pressure Below 50 psi

1. Accomplish steps 1 thru 4 above.

If no correction noted:

2. Land when practicable.

No Pressure on System

1. Both systems - ON.
2. Accomplish steps 1 thru 4 above.

If no correction:

3. Inoperative system - OFF.
4. Land when practicable.

PERSONAL EQUIPMENT INDICATIONS

No suit pressure when TEST IND button pressed

1. Descend below suit inflation altitude.
2. Land when practicable.

Reduced oxygen flow in helmet - (Both systems)

1. Green apple - Pull.
2. Descend to safe altitude.
3. Land when practicable.

Constant oxygen flow in helmet

1. Both systems - OFF then ON.
2. One system - OFF.
3. Visor control - Depress 3-5 seconds.
4. Both systems - ON
5. Repeat on other system if necessary.

If no correction:

6. Both systems - OFF.
7. Green apple - Pull.
8. Descend to safe altitude.
9. Land when practicable.

Green apple loose from snap (possible active system)

1. Observe pressure gage on green apple.

If indicator shows full:

2. Replace green apple and continue flight at pilot's discretion.

Poor or no communications

1. Check communications lead for accidental disconnect.

LANDING EMERGENCIES

SINGLE ENGINE LANDING

A single engine landing is basically the same as a normal landing, except that the pattern may be entered at any point and is expanded to avoid steep turns. Airspeed is maintained above the normal value on final approach. The outstanding difference from normal landings is the noticeable change in directional trim with power changes. The most marked trim change will occur as the throttle is retarded during flare. This may be anticipated and rudder trim set to neutral on the trim indicator after final approach is established. Directional heading is maintained by rudder pressure until thrust is smoothly reduced during the flare. The landing gear may be lowered after lining up on final approach with the left hydraulic system operating; however, at least 90 seconds must be allowed for emergency gear extension if the left system is inoperative.

1. Fuel - DUMP and TRANSFER as required.
2. Hydraulic system - Review services available.
3. If left engine is inoperative, brake switch - ALT STEER & BRAKE.
4. Inoperative engine SAS pitch and yaw switches - OFF.
5. SAS roll switches - Both OFF.
6. Operative engine SAS roll switch - ON.
7. Landing gear lever - DOWN.
8. Establish steeper than normal final approach.
9. Maintain 200 KIAS minimum until landing is assured.

NOTE

If it is necessary to land with more than 35,000 pounds of fuel remaining increase minimum approach speed 1 knot for each additional 1000 pounds.

10. Rudder trim - Neutral.
11. When landing assured - Retard throttle.
12. Make normal landing.

SIMULATED SINGLE-ENGINE LANDING

Directional trim changes will be more pronounced during an actual single engine situation with one engine windmilling.

1. Retard one throttle to IDLE.
2. Follow Single Engine Landing procedure.

SINGLE ENGINE GO-AROUND

Make decision to go around as soon as possible and definitely prior to flare.

1. Throttle - As required.
2. Continue approach until go-around is assured.
3. Landing gear lever - UP, as appropriate.

   Delay gear retraction until there is no possibility of contacting the runway.
4. Trim - As necessary.
5. Accelerate to 250 KIAS.

LANDING GEAR SYSTEM EMERGENCIES

GEAR UNSAFE INDICATION

An unsafe indication could be caused by low L hydraulic system pressure or malfunction within the landing gear extension or indicating system. Upon detecting an unsafe gear indication, proceed as follows:

1. Land gear control and indicator circuit breakers - Check IN.
2. L hydraulic pressure - Check.
3. Recycle landing gear lever to down position, repeat as desired and pull emergency gear release handle if necessary.

If landing gear still indicates unsafe:

4. Landing gear position - Request visual confirmation.
5. If all landing gear appear fully extended, make a normal landing on side of runway away from suspected unsafe gear. Observe the following precautions:
   a. Shoulder harness - Manually lock.
   b. Hold weight off unsafe gear as long as possible then allow gear to contact runway as smoothly as possible. If nose gear is held off, lower nose at approximately 110 KIAS.
   c. Allow aircraft to roll to a stop straight ahead, have downlocks installed prior to further taxiing or engine shutdown.
6. If any gear remains fully retracted, use Emergency Extension procedure.
7. If all gear are not fully extended, refer to Partial Gear Landing procedure, this section.

NOTE

- Increasing airspeed may assist in locking a partially extended nose gear.
- Yawing aircraft may assist in locking a partially extended main landing gear.

GEAR EMERGENCY EXTENSION

The emergency landing gear extension system unlocks the landing gear uplocks and allows the landing gear to free fall to the down and locked position. If R hydraulic system pressure is available, the landing gear handle must be placed in the DOWN position or the landing gear control circuit breaker must be pulled to permit emergency extension. The time required for emergency gear extension is 60 to 90 seconds. The emergency landing gear handle must be pulled approximately 9 inches for full actuation. If it is not fully actuated, one or more gear may fail to extend.

If the L hydraulic system has decreased below 2000-2200 psi or normal gear extension is unsuccessful, proceed as follows:

1. Landing gear handle - DOWN.
2. Emergency landing gear release handle - PULL.
3. Verify gear down and locked.

If L hydraulic system pressure low:

4. Brake switch - ALT STEER & BRAKE.

NOTE

Alternate nosewheel steering is available when L system pressure decreases below 2200 psi.

If landing gear remains retracted or landing gear handle sticks in the UP position:

5. Landing gear control circuit breaker - PULL.

6. Repeat steps 2 and 3 of this procedure.

Note

When the landing gear control circuit breaker is pulled nosewheel steering will be inoperative.

CAUTION

The landing gear must not be retracted if the manual release handle is being held in the free fall (full out) position as damage to the system can result. The GEAR RELEASE handle should be permitted to return to the stowed position before attempting to retract the gear with the landing gear lever.

PARTIAL GEAR LANDING

A landing with the nose gear retracted or with all gear up should not be attempted. Under ideal circumstances, a landing with the nose gear extended and both main wheels retracted may be possible. If this configuration can be accomplished, base a decision to land or eject on whether other factors are favorable or not. Wind velocity and direction are important in selection of the landing heading.

If a decision is made to land, conventional final approach and landing speeds and attitudes are recommended. This will result in the tail touching while the nose is at less than normal height. An attempt to hold the aircraft off by using a higher pitch angle is not recommended because of the greater possibility of high impact loads as the nose gear slaps down. An empty tank 1 condition is desired.

1. Accomplish nose gear only configuration if necessary as follows:

   a. Landing gear CONT circuit breaker - Push in.

   b. Landing gear lever - Up.

   c. Landing gear CONT circuit breaker - Pull.

   d. Manual landing gear release handle - Pull to release nose gear only (first lock releases nose gear). Check nose gear down light - ON.

2. Do not transfer fuel forward.

3. Fuel dump switch - DUMP, if necessary to reduce weight.

4. Igniter purge switch - Dump during approach.

5. Battery switch - OFF.

6. Inertia reel lock lever - LOCK.

7. Canopy jettison handle - Pull, if desired.

NOTE

If the canopy is not jettisoned prior to landing, it should not be unlocked until the aircraft has stopped.

8. Make normal approach and landing.

9. Drag chute handle - Pull.

10. Use rudders for directional control.

11. Throttles - OFF, when directional control is no longer possible.

12. Abandon aircraft as quickly as possible.

MAIN GEAR FLAT TIRE LANDING

Plan the landing for minimum gross weight with touchdown to be made on the side of the runway away from the flat tire. It is possible that only one or two of the three tires has failed. If only one tire has failed, little danger exists when landing at low weight because two tires have sufficient strength to support the aircraft.

1. Touch down on good tires.

2. Drag chute handle - Pull, as soon as possible.

3. Nosewheel - Lower.

4. Nosewheel steering - Engage.

5. Hold weight off bad side as long as possible using full aileron.

WARNING

Maintain IDLE rpm until fire-fighting equipment arrives. Engine shutdown allows fuel to vent in the vicinity of the wheel brake area, thus creating a fire hazard.

NOSE GEAR FLAT TIRE LANDING

If it is necessary to land with a flat nosewheel tire or tires, avoid a forward c. g. if possible and proceed as follows after making a normal touchdown.

1. Drag chute handle - Pull.

2. Nose gear - Hold off.

   Hold the nosewheel off as long as practicable (approximately 110 KIAS) and then lower gently to runway.

3. Use nosewheel steering and differential braking to maintain directional control.

After stop, before shutdown:

4. Fuel - FWD TRANS.

HEAVY WEIGHT LANDING

Use normal procedure, observing operating limits of Section V.

ABBREVIATED CHECKLIST

The emergency abbreviated checklist is furnished separately.

AUXILIARY EQUIPMENT

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COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

The communication, electronic navigation and instrument approach equipment includes the following:

AN/ARC-50 UHF Communication, direction finding and ranging equipment.

DF 203 ADF Receiver

AN/ARN-52 TACAN Equipment

ILS Equipment

HF (618T) Radio Equipment with Sel-Call Decoder

[redacted] Equipment

IFF Equipment

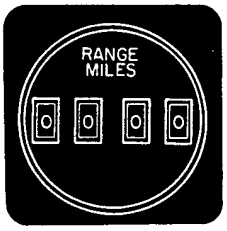
AN/AIC-18 Interphone Equipment

AN/ARC-50 UHF RADIO NAVIGATION SYSTEM

AN/ARC-50 equipment is capable of transmitting and receiving on any of 3500 channels in the frequency range of 225.00 to 399.95 MC. The equipment can be operated in either of two basic modes; an internal (narrow band) mode in which its operation is compatible with any conventional UHF radio communication set, and an external (wide band) mode in which it has high resistance to jamming and low detectability. In this mode it incorporates message privacy and range measurement functions. When used in conjunction with the UHF DF system and AN/ARA-50 set it provides direction finding capability in either mode.

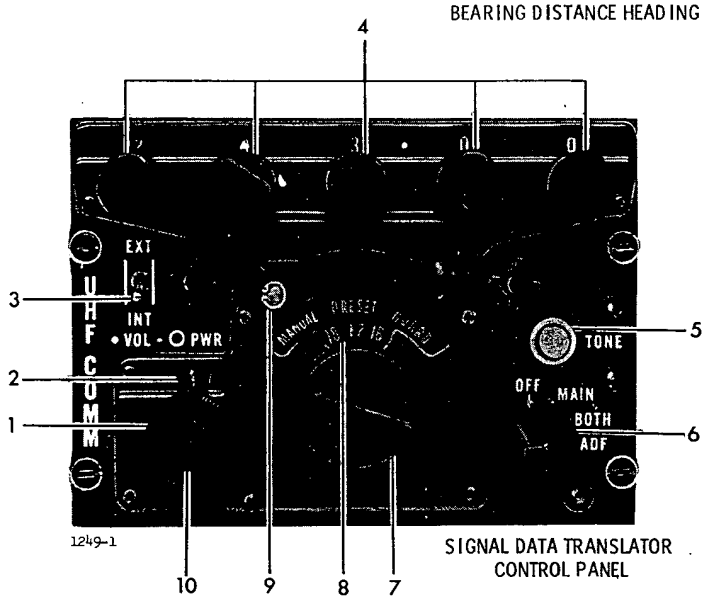
In the internal mode power output is a nominal 30 watts minimum while in the enternal mode the power output is approximately 50 watts. The power output in either mode may be reduced in 10 steps of 9 db increments to a fraction of a watt.

UHF RADIO PANELS AND INDICATORS

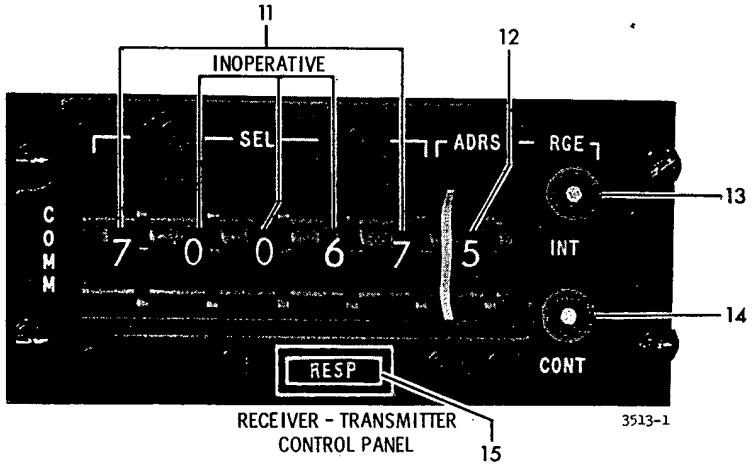


RANGE INDICATOR

BEARING DISTANCE HEADING INDICATOR (BDHI)



SIGNAL DATA TRANSLATOR CONTROL PANEL



RECEIVER - TRANSMITTER CONTROL PANEL

1 POWER SELECTOR SWITCH
2 POWER SELECTOR INDICATOR
3 INTERNAL - EXTERNAL SWITCH
4 MANUAL FREQUENCY SELECTOR SWITCHES AND INDICATORS
5 TONE BUTTON
6 FUNCTION SELECTOR SWITCH
7 PRESET CHANNEL SELECTOR SWITCH
8 PRESET CHANNEL INDICATOR
9 MANUAL - PRESET - GUARD SELECTOR AND INDICATOR
10 VOLUME CONTROL KNOB
11 CODE SELECTOR SWITCHES
12 RANGE ADDRESS SWITCH
13 RANGE INTERROGATE SWITCH
14 CONTINUOUS RANGE SWITCH
15 RESPONSE LIGHT

F200-Z9(e)

Figure 4-1

Most of the AN/ARC-50 equipment is mounted in the pressurized and cooled nose compartment and includes the blower cooled translator group, the receiver-transmitter group and a separate inverter. AN/ARA-50 direction finding equipment and the flush antenna are also mounted in the nose compartment.

The AN/ARC-50 control panels are mounted on the pilot's left console. A range indicator is mounted on the instrument panel. The direction finding equipment is also connected to the No. 1 needle of the BDHI when the equipment is operating. The communication antenna is mounted in the lower right chine. Power for the equipment is provided by the essential dc bus. The left generator bus supplies blower and heater power.

SIGNAL DATA TRANSLATOR CONTROL PANEL

The translator control panel labeled UHF COMM is located on the left console. It incorporates provisions for control of frequency and power output, mode of operation and receiver volume. It provides the pilot with 20 preset frequency channels, provision for manually selecting any of 3500 frequencies and controls for operation of the separate fixed tuned guard channel receiver.

Function Selector Switch

This four position rotary switch is labeled OFF, MAIN, BOTH and ADF. In the OFF position the equipment is not energized. In the MAIN position the translator group equipment is energized with only the transmitter and main receiver operative. In the BOTH position the equipment is energized with the transmitter and both main and guard receivers are operative. In the ADF position the AN/ARA-50 equipment is energized and the main receiver and the transmitter are operative. The No. 1 needle of the BDHI is also disconnected from the DF 203 ADF receiver or TACAN receiver and receives directional signals from the ARA-50 equipment.

Manual-Preset-Guard Selector Lever and Indicator

This selector lever controls the manner of frequency selection. In the MANUAL (left) position the manual frequency selector switches are activated and the frequency selected is visible in the cutouts above each switch. In the PRESET (center) position the preset channel selector switch is activated and the channel selected is displayed in the window below the Preset indicator. In the GUARD (right) position the guard channel frequency is set on the main receiver and transmitter, and GUARD is indicated in the window below the selector lever knob.

Preset Channel Selector Switch

This switch, located in the center of the panel, selects one of twenty preset frequencies when the manual preset guard selector knob is positioned to PRESET and indicates the frequency channel selected in the window beneath the Preset indicator. The channel numbers are blanked out when MANUAL or GUARD is selected.

Frequency Selector Switches and Indicators

Five rotary switches across the top of the panel permit manual selection of any one of 3500 frequencies in the 225.00 to 399.95 mc range. These switches are activated when the manual-preset-guard selector knob is positioned to MANUAL. Each switch is used to select the digit displayed in the cutout above.

INT-EXT Mode Switch

This two position switch is labeled INT-EXT. In the INT position the translator transmits and receives narrow band AM signals independent of the receiver-transmitter equipment. This position is used for conventional UHF transmitting and receiving. In the EXT position the signal translator and receiver-transmitter are used together to receive and transmit the wind band pseudo-noise encoded signals. The EXT position is also used for direction finding and/or ranging functions. The power selector switch may be used to regulate the transmission power in either position.

Power Selector Switch and Indicator

The rotary switch is the larger of the two concentric knobs and controls the output of the transmissions from the translator and receiver-transmitter combination. It has ten positions labeled 1 to 10 to permit setting power output from the maximum of 30 watts (10) to a low of .3 microwatts (1) in 9 db increments in the INT or narrow band mode. In the EXT or wide band mode power is increased to a maximum of 50 watts but also may be reduced in the 9 db units to approximately 1.0 microwatt. The digit in the cutout above the knob indicates the power output selected. The A position, providing for an additional amplifier, is operative but power output is the same as the 10 position.

Volume Control

This is the smaller center knob concentric with the power selector switch and adjusts the audio level of the receivers. Clockwise rotation will increase volume.

Tone Button

This button is located on the right side of the panel. When depressed, a 1020 cycle tone is produced for audio checking or transmission on either INT or EXT mode.

RECEIVER-TRANSMITTER CONTROL PANEL

The receiver-transmitter control panel located just aft of the translator control on the left console is used when operating in the external or wide band mode only. In this mode of operation the AN/ARC-50 provides the following functions:

1. Secure voice communications.
2. Semi Automatic Direction Finding.
3. Semi Automatic Range Measurement.
4. Automatic Ranging.
5. Automatic Ranging and Direction Finding.

The panel contains rotary selector and range address switches with position indicators, pushbutton interrogation and continuous ranging switches and indicating lights and a separate response indicator light. These switches and lights are only operative when the INT-EXT mode switch is in the EXT position.

Code Selector Switches

Five rotary type digital indicating selector switches labeled SEL are provided on the panel. The digital window type indicators have positions labeled from 0 to 7. Communicating stations must have identical code selecting settings in order to establish wide band communication.

NOTE

In this installation only the 1st and 5th selector switches are operative giving 64 possible code selections. 2nd and 3rd selector switches must be on 0 and the 4th select switch must be on 6.

Range Address Switch

The inboard or 6th rotary selector switch labeled ADRS-RGE is used for selective ranging. It has eight positions which show position indications of 1 thru 5 inclusive for 5 possible range addresses. The other three positions are labeled A, O, and T. The A position allows for a range measurement on any terminal regardless of its address (ADRS-RGE) code. This is considered an emergency code. The O position is an off position which prevents another terminal from ranging although voice communication capability is retained. The T position is a test position for checking indicator lights on the translator and receiver transmitter panels.

Range Interrogate Switch and Indicator Light

This pushbutton switch containing an integral light is used to make interrogation of direction and range in the external mode. When the translator function selector switch is in the ADF position the one time bearing reading will be indicated on the No. 1 needle of the BDHI. If the translator function switch is in the MAIN or BOTH position pressing the INT button will provide a one time range measurement in nautical miles and tenths. Normal time for one time directional or range indication is 3 seconds. The button is also used to establish automatic ranging and automatic ranging and direction finding in combinations with the CONT button. The button will be momentarily depressed and the light illuminated while the ranging or direction range is being obtained. The light will be extinguished after approximately 3 seconds.

Continuous Range Switch

This pushbutton switch and integral light labeled CONT, when pressed, sets the receiver-transmitter into a continuous automatic ranging or combination ranging and DF conditions. This condition is activated by the interrogate button provided that the other station has previously activated their continuous range operation. The light is illuminated at both stations while continuous ranging or ranging and DF operation is in effect. The range indicator and No. 1 needle of the BDHI will be updated every 5 seconds. Either station pressing its CONT button or MIC button will terminate the automatic cycle. When the cycle is completely broken the range indicators will return to 000.0 miles.

Response Light

The response light, labeled RESP, will be illuminated when the AN/ARC-50 is answering a range measurement interrogation from another aircraft or station.

DISTANCE INDICATOR

The distance indicator is mounted on the upper left side of the instrument panel and displays the distance between two ranging AN/ARC-50 sets. Negative contact will result in a 000.0 reading.

UHF ANTENNAS

The UHF communication antenna is located on the lower right chine and remains ex-

tended. Provisions are available to hydraulically retract the antenna flush. The UHF-ADF antenna is mounted on the bottom of the nose compartment and is the receiving antenna at any time the function switch on the translator is in the ADF position. It is optimized for the DF function and communications and ranging will be inferior when using this antenna for other than the direction finding function.

NORMAL OPERATION

Internal Mode UHF Communications

1. Microphone selector switch - UHF.
2. Function switch - MAIN or BOTH.
3. INT-EXT switch - INT.
4. Power selector switch - Set.
5. MANUAL-PRESET-GUARD lever - As desired.

NOTE

If GUARD is selected frequency selection will be automatic.

If MANUAL:

6. Frequency selector switches - Set.

If PRESET:

7. Channel selector switch - Set.
8. Mic button - Press.
9. Volume control - As desired.

External Mode UHF Encoded Communication

NOTE

External mode is applicable only when communication is with another AN/ARC-50 station.

1. Microphone selector switch - UHF.
2. Function switch - MAIN or BOTH.
3. INT-EXT switch - EXT.
4. Power selector switch - Set.
5. MANUAL-PRESET-GUARD lever - MANUAL or PRESET as desired.

NOTE

If GUARD is selected communications will be in the narrow band conventional mode even though INT-EXT switch is in EXT.

If MANUAL:

6. Frequency selector switches - Set.

If PRESET:

7. Channel selector switch - Set.
8. Code selector switches - Set.
9. Range address switch - 0 or as desired.
10. Mic button - Press (tone will be heard for approximately 1 second).
11. Volume control - As desired.

Semi Automatic Ranging

A one time range interrogation is made as follows:

1. Select proper frequency and power.
2. Function switch - MAIN or BOTH.
3. INT-EXT switch - EXT.
4. Code Selector switch - Set.
5. ADRS-RGE selector switch - Set.
6. INT button - Press. Light will illuminate for approximately 3 seconds.

When the light extinguishes range indication may be read.

To update range reading:

7. INT- Press.

To communicate with range partner:

8. Mic button - HOLD. Wait for tone to mute.

Automatic Ranging

Automatic continuous ranging with both stations receiving continuously updated range information every 5 seconds is accomplished as follows:

1. Frequency and power - Set.
2. Function switch - MAIN or BOTH.
3. INT-EXT switch - EXT.
4. Code selector and range address switches - Set.
5. Request selected range partner to press CONT button.
6. CONT button - Press.
7. INT button - Press.
8. CONT light - Check on.
9. INT and RESP light - Check alternate illumination. Both stations will receive updated range readings every 5 seconds.

NOTE

After a continuous range is established, if a ranging interrogation cycle is not completed, the equipment will automatically re-interrogate once. The digital range indication will be held during this period for approximately 10 seconds and, if ranging is not re-established, then reset to zero.

To resume communication:

10. Mic button - Press. Tone will be heard for 0-10 seconds depending on which part of the ranging cycle is in progress.

NOTE

First transmission after muting will be to ranging partner only. Subsequent transmissions will be heard by all stations having identical code selections.

11. Volume control - Adjust.

ADF Operation

During ADF operation the AN/ARA-50 equipment and directional antenna are used for receiving, and the direction of signals from the responding UHF station will be indicated by the No. 1 needle of the BDHI.

Internal Mode Direction Finding

For DF operation in conventional narrow band mode proceed as follows:

1. Select proper frequency and power.
2. Function switch - ADF.
3. INT-EXT switch - INT.
4. Request communicating station for continuous transmission or tone.
5. Bearing to transmitting station will be indicated by the BDHI No. 1 needle.

External Mode Direction Finding

For semi automatic or one time ADF bearing proceed as follows:

1. Select proper frequency and power.
2. Function switch - ADF.
3. INT-EXT switch - EXT.
4. Code selector switch - Set.
5. Range address switch - Set.
6. INT button - Press momentarily. Light will illuminate for approximately 3 seconds. When light is extinguished, bearing will be indicated by the BDHI No. 1 needle.

To update bearing:

7. INT button - Press.

To resume communication:

8. Mic button - HOLD.

For continuous updated ranging and automatic direction bearing proceed as above except:

1. Request ranging partner to press CONT button.
2. CONT button - Press.
3. INT button - Press.

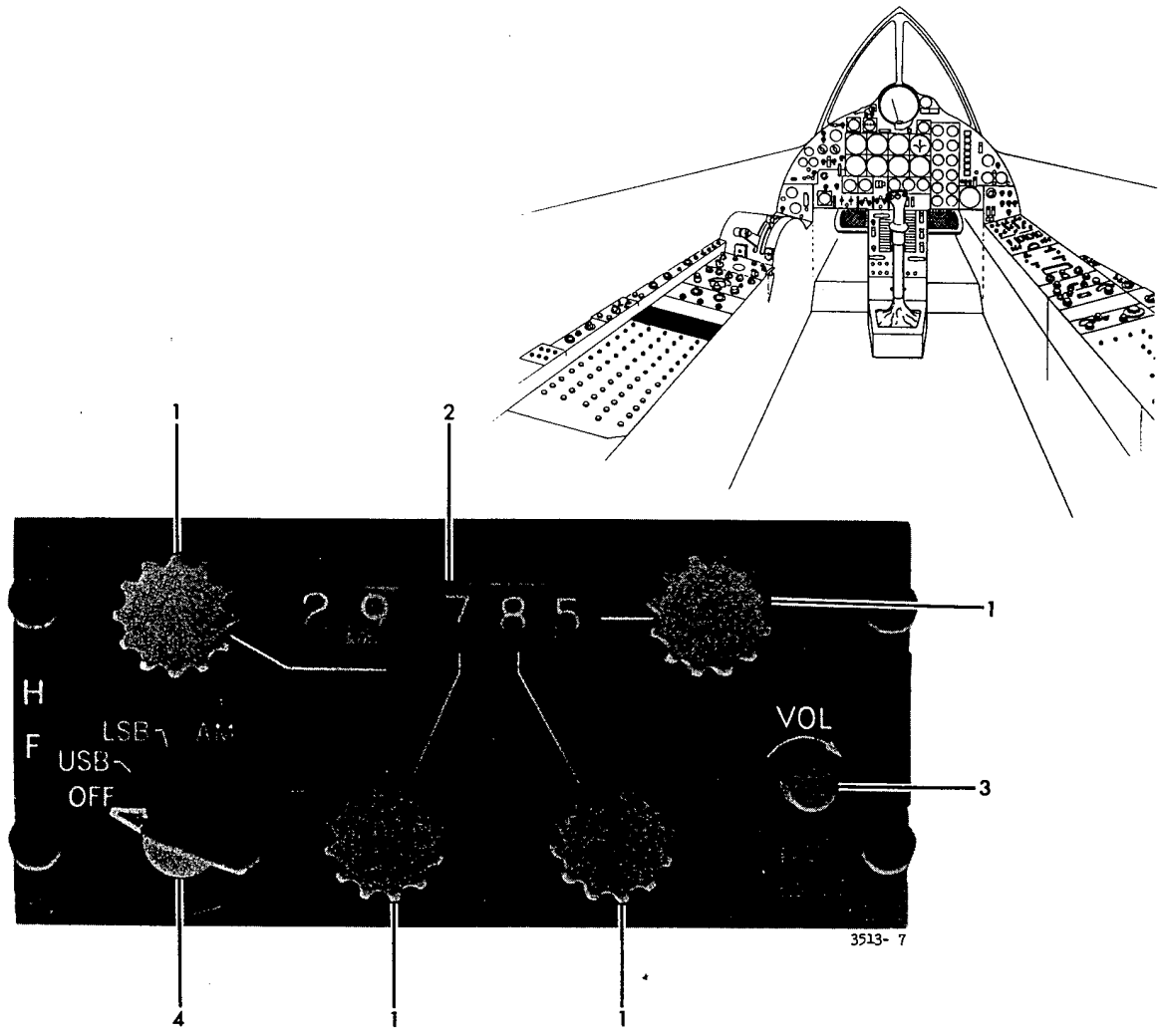
NOTE

Holding the Mic button until tone stops (0-8 seconds one way ADF and 0-12 seconds two way ADF) terminates the automatic ranging and ADF functions. The CONT and INT buttons will re-establish the continuous ranging and ADF cycles.

BEARING, DISTANCE, HEADING INDICATOR (BDHI)

The bearing, distance, heading indicator located on the left side of the instrument panel contains a rotating compass card, a range shutter labeled OFF covering the digital distance readout, and No. 1 and No. 2 directional indicating needles. The card displays true or magnetic heading depending on the position of the INS mode switch. In the NAV position, true heading using the INS as a reference will be indicated at the lubber line. In the FRS position, magnetic heading from the FRS will be indicated. The No. 1 needle will read an ADF bearing from the DF 203 unless the AN/ARC 50 is operating in the ADF mode; or TACAN bearing depending on the position of the No. 1 needle selector switch. The No. 2 needle will indicate the steering direction from the INS. When reliable TACAN information is being received the range shutter will be up and the range readout will represent slant range to the TACAN station being interrogated.

HF RADIO PANEL



1 FREQUENCY SELECTOR SWITCHES
2 FREQUENCY INDICATOR
3 RF SENSITIVITY CONTROL
4 SERVICE SELECTOR SWITCH

F200-41(b)

Figure 4-2

BDHI No. 1 Needle Selector Switch

This two position switch is located on the right console. It selects either the TACAN or DF-203 ADF inputs to the No. 1 BDHI needle, provided the AN/ARC-50 is not operating in the ADF mode. In the TACAN (forward) position, the No. 1 needle of the BDHI is connected to the TACAN receiver and the needle indicates the bearing to the selected TACAN station. In the ADF (aft) position, the No. 1 needle indicates the bearing to the selected station. When the AN/ARC-50 is operating in the ADF function, the switch is inoperative and the No. 1 needle indicates the bearing to the selected ARC-50 station.

COURSE INDICATOR (ID 249)

The ID-249 course indicator is installed on the center instrument panel. It is used in conjunction with the BDHI to indicate course deviation when operating the TACAN system. It is also used to indicate course and glide slope deviation and marker beacon passage when operating the ILS receivers. The indicator contains a course set knob, a course selector window to show course selected, a vertical CDI course deviation needle and dot deviation scale, a horizontal glide slope indicator needle and dot deviation scale, (GSI), a TO-FROM indicator window, GSI & CDI warning flags (OFF), a heading pointer with right and left pointer scales and a marker beacon light. The indicator is powered by signals from the respective receivers.

618T HF RADIO EQUIPMENT

The 618T is a long range airborne single side band (SSB) voice communications transceiver which transmits and receives in the 2 to 30 megacycle range. The transceiver can be tuned in one kilocycle steps. The primary operating mode is SSB, using either the upper or lower side of the modulated signal, which allows all the power to amplify the side band selected. The equipment can also transmit and receive AM signals.

The equipment consists of the transceiver with an antenna tuner which is mounted in the pressurized nose compartment. The antenna is the pitot boom and insulated forward portion of the aircraft nose. This equipment has been modified to use fixed frequency ac power from the No. 1 inverter for those circuits which are frequency critical and variable frequency ac power normally furnished from the left generator for non-critical main ac power. A frequency sensing relay is provided to transfer this main ac power source if the left or operative generator bus drops below 325 cycles (4500 engine rpm) to the ARC-50 inverter if the COMM selector switch is in the HF position. Control circuit power is supplied by the essential dc bus.

618T HF Control Panel (714 E-2)

The control panel for the HF equipment is located on the left console and contains the following:

Service Selector Switch

This switch turns the equipment on or off and selects the desired operating mode. In the USB (upper side band) position, only the upper side band signal is transmitted or received. This is the sum of the voice signal and the radio frequency (rf) signal. In the LSB (lower side band) position, only the lower side band signal is transmitted or received. This signal is the difference of the voice signal and the rf signal. In the AM position the signal is amplitude modulated and both side bands and the original rf signal are transmitted and received.

Frequency Selector Switches

The first switch selects the proper megacycle point as indicated by the digits in the first two windows. It will indicate from 02 to 29. The frequency will increase as the knob is rotated clockwise and decrease as the knob is rotated counterclockwise.

The 100 kc knob selects the proper one hundred kilocycle point and indicates from 0 to 9 in the third window. The 10 kc knob selects the desired ten kilocycle point and indicates from 0 to 9 in the fourth window. The one kc knob selects the desired one kilocycle point and indicates from 0 to 9 in the right window.

Volume Knob

This knob is used to adjust the audio level in the headphones.

NORMAL OPERATION

1. Service selector switch - Set to desired mode. This will turn the equipment on. For normal voice communication this may be USB, LSB or AM.

2. Frequency selector switches - Set to desired operating frequency. The muting of sound in the headphones will indicate the equipment is setting to the new frequency.

Note

The service selector switch may have been moved from the OFF position to an operating mode with the desired operating frequency already set up. In this case, rotate the ten kc select knob one digit off frequency and then back to the operating frequency. This will allow the equipment to return to the desired frequency.

3. COMM selector switch - HF.

When background sound is again heard in the headphone:

4. TRANS-button - Press. Wait for the equipment to tune - a 1000 cps tone will be heard until tuning is complete.

When the equipment is tuned (no 1000 cps tone):

5. VOL knob - Adjust so that background noise in headphones is barely audible.

EMERGENCY OPERATION

If a short circuit exists in the output of the power supply, a protective circuit turns off the equipment. Restore to operation as follows:

1. Service selector switch - OFF, then back to desired operating mode.

NOTE

When the antenna coupler is required to complete several consecutive tuning cycles, a thermal relay will de-energize the equipment. Restore to operation as follows:

1. Service selector switch - OFF. After two minutes the thermal relay will cool.

2. Service selector switch - To desired operating mode.

If HF and/or BW operation is required with inoperative engines or generators:

1. HF & BW power switches - On.

2. COMM selector switch - HF.

NOTE

The COMM selector switch must be in the HF position to provide continuous HF or BW communication with windmilling engines and/or inoperative generators. In this position automatic transfer of main ac power from the left generator to the ARC-50 inverter is accomplished if the frequency of the left generator bus drops below 325 cycles or 4500 engine rpm. At below 2800 engine rpm or 200 cycles the automatic bus transfer occurs and if the right engine or generator bus is above 325 cycles (4500 engine rpm) the frequency relay will reconnect the main ac power to the right generator power source.

SEL CALL DECODER

The Sel Call Decoder provides a convenient method for the selective reception of HF transmissions. It will recognize a call on a selected channel of the HF receiver and unmute the receiver when the proper call signal is received. The decoder operates in a preset Sel Call coder frequency and will recognize only this channel. A momentary contact switch and indicating light is on the left console to MUTE or UNMUTE the HF audio circuit. The indicator light is illuminated when the decoder is in the muted mode. The Sel Call Decoder is also automatically unmuted when the transmitter key is pressed which provides audio sidetone during transmission to the pilot's headset. Power for the Sel Call Decoder is furnished by the dc essential bus.

X BAND BEACON

The aircraft is equipped with an X band beacon and an EGG beacon. The X band beacon transponder is located in the nose compartment with the flush antenna mounted on the lower fuselage just aft of the nose boom. The EGG beacon transponder and antenna are mounted on the lower Q-bay hatch. Both beacons are controlled by a 3 position toggle switch located on the left console. The switch is labeled EGG-OFF-TNKR. Power for the transponder is furnished by the dc essential bus.

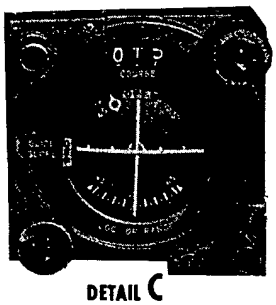
TACAN SYSTEM AN/ARN-52

The TACAN system provides continuous indications of bearing and slant distance to a selected surface beacon or to another aircraft containing the necessary transponder equipment. The system transmits interrogation pulses which trigger responding pulses from the selected ground station or aircraft. Slant distance to the station or aircraft is computed from the elapsed time. Both bearing and distance are visually displayed on the bearing, distance heading indicator on the instrument panel. The system is capable of operation on any one of the 216 channels and has a range of about 300 nautical miles. The transmitting frequency range is 1025 to 1150 megacycles. Frequency ranges for reception are; low band normal, 926-1024 megacycles, air to air 1088-1150 megacycles; high band normal, 1151-1213 megacycles, air to air 1025-1087 megacycles. Power for the equipment is furnished by the left ac generator and essential dc buses.

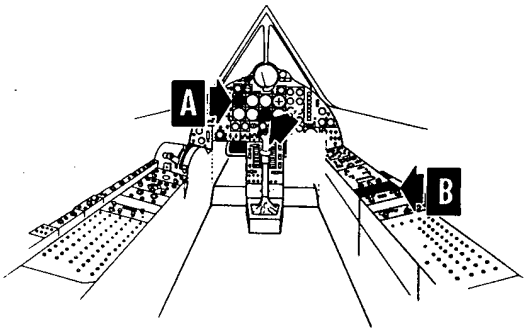
AN/ARN-52 Control Panel

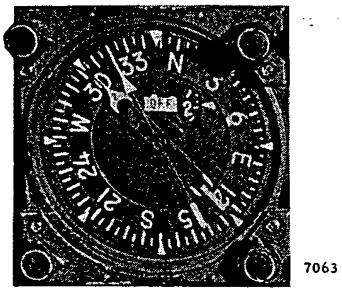
A control panel is installed on the right console. The panel contains a channel selector switch, mode selector switch and a volume control.

TACAN CONTROL PANEL AND INDICATORS

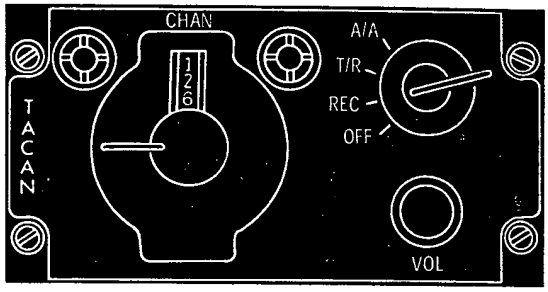


DETAIL C
COURSE INDICATOR





DETAIL A
BEARING DISTANCE HEADING INDICATOR (BDHI)



DETAIL B
TACAN CONTROL PANEL

F200-66(a)

Figure 4-3

Channel Selector Switch

A channel selector is used to select any one of the available channels. Selection is accomplished by setting the desired number in the channel window using the concentric knobs. The outer knob selects the first two digits and the inner knob selects the third digit of a desired channel.

Volume Control Knob

Audio level of the TACAN station identification signals is increased by rotating the volume (VOL) control clockwise.

Mode Selector Switch

The mode selector switch has four positions.

OFF - The set is de-energized.

REC - The set is energized and presents bearing and course information on the BDHI and course indicator.

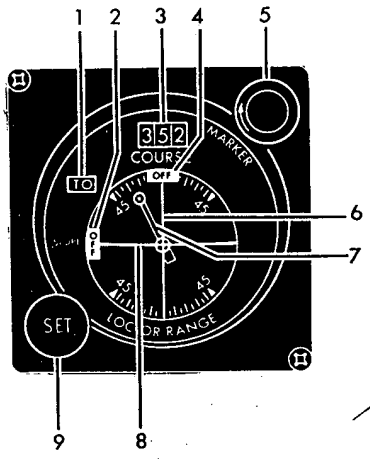
T/R - Same as the REC position and also presents range in nautical miles to a TACAN station on the BDHI.

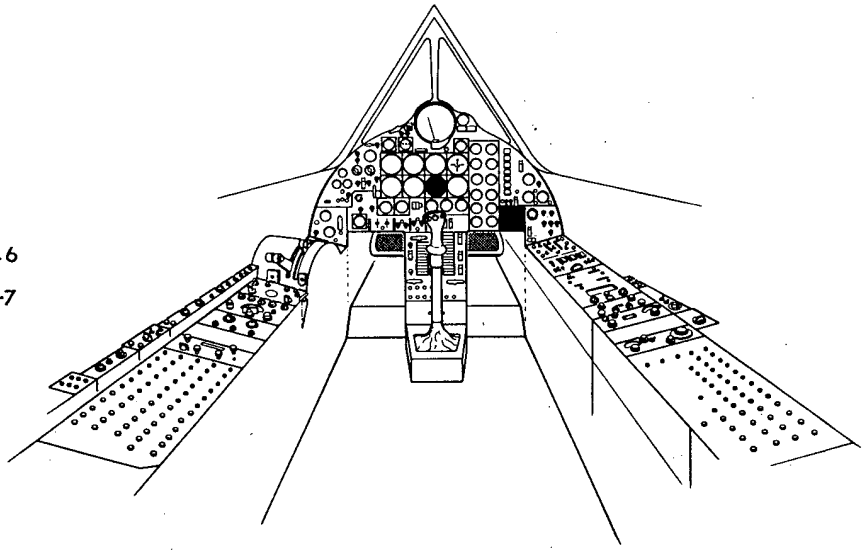
A/A - Same as the REC position and also presents range in nautical miles and bearing to another properly equipped aircraft.

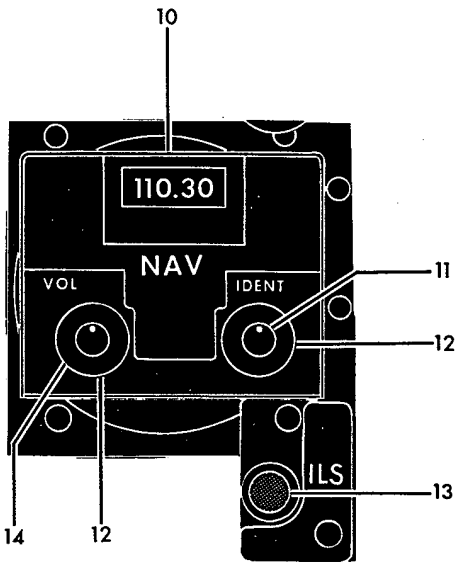
OPERATION OF THE TACAN SYSTEM

1. INS mode switch - FRS if operative.
2. TACAN mode selector switch - REC.

ILS CONTROL PANEL







1 TO-FROM INDICATOR
2 GLIDE SLOPE SIGNAL OFF FLAG
3 BEARING SELECTOR INDICE
4 LOCALIZER-VOR OFF FLAG
5 MARKER BEACON LIGHT
6 COURSE DEVIATION NEEDLE (C. D. I.)
7 HEADING INDICATOR
8 GLIDE SLOPE INDICATOR (GSI)
9 BEARING SELECTOR KNOB
10 FREQUENCY INDICATOR
11 AUDIO IDENTIFICATION CUTOUT
12 FREQUENCY SELECT SWITCH
13 ILS ON LIGHT
14 VOLUME-ON-OFF SWITCH

F200-31(a)

Figure 4-4

Allow 90 seconds for warmup:

3. Channel selector switch - Desired channel.

4. Adjust VOL as desired and verify station identification.

5. No. 1 needle selector switch - TACAN.

6. Observe bearing pointer on BDHI: To-From indication on course indicator.

7. Mode selector switch - T/R, or A/A.

8. Observe range to station or aircraft on BDHI.

Bearing, Distance, Heading Indicator (BDHI) No. 1 Needle

The BDHI No. 1 needle may be connected to the TACAN receiver by the BDHI No. 1 needle selector switch. If the receiver is tuned to a TACAN station, the No. 1 needle will indicate the bearing to the station. Refer to BDHI this section.

ILS EQUIPMENT

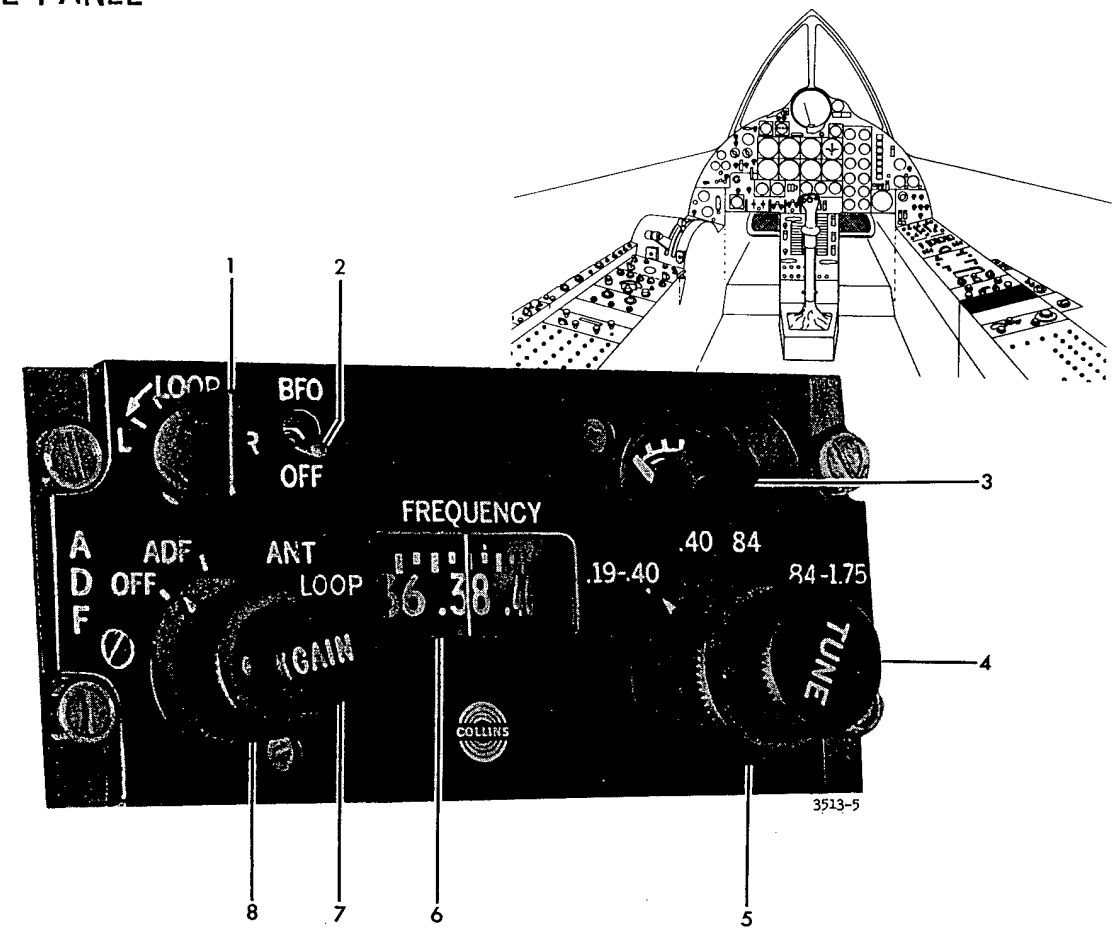
ILS equipment consisting of localizer, glide slope and marker beacon receivers are provided for ILS approaches. In addition the equipment includes a control panel and indicating light, the ILS converter and associated antennas. Localizer, glide slope and marker beacon signals are reflected on the ID-249 course indicator. Localizer signals are not reflected by the No. 1 needle of the BDHI which continues to show TACAN or HF/UHF ADF bearings as selected.

The localizer receiver tunes odd tenth megacycle localizer frequencies between 108.10 to 111.90 mc. It will also tune VOR voice or tone signals between even tenths from 108.0 to 112.0 and all tenths between 112.1 thru 117.9 mcs. VOR signals will not be reflected on the ID-249 course indicator. The associated glide slope frequencies between 329.3 to 335 megacycles will be automatically tuned when the receiver is tuned to the desired localizer frequency. The localizer ON-OFF-VOL control also activates the fixed tuned 75 megacycle marker beacon receiver and marker beacon signals are reflected by coded audio tones in the headset and coded flashes of the single marker beacon light on the ID-249 course indicator. As the marker beacon antenna is located on the inside of the nosewheel door the marker beacon will only be usable with the landing gear down. The ILS ON light is provided to indicate that the localizer is furnishing signals to the ID-249 course indicator and that TACAN signal inputs are disconnected from that instrument. TACAN bearing and range to selected stations will still be available on the BDHI. All receivers are solid state and operate with power furnished by the essential dc bus.

ILS Control Panel

The ILS control panel is located on the lower right side of the instrument panel. The panel controls consist of a ON-OFF-VOL control concentric with a larger frequency (megacycle) selector on the left side of the panel. The small knob turns the ILS equipment from off to on and further clockwise rotation will increase the volume of voice reception or tone identification. The larger knob selects the 3 digit megacycle frequency of the desired localizer station which is indicated in the window in the center of the panel. The right hand side control knobs are also concentric with the small center knob to eliminate tone identification from the headset. The larger concentric knob controls the 2 digit tenths and hundreth mc frequency selector which is indicated in the frequency window. The ILS ON light is located just above the panel

ADF CONTROL PANEL



1 LOOP CONTROL
2 BFO SWITCH
3 TUNE-FOR-MAX INDICATOR
4 TUNING CONTROL
5 BAND SELECTOR SWITCH
6 FREQUENCY INDICATOR WINDOW
7 GAIN CONTROL
8 FUNCTION SWITCH

3-16-65
FMA12-45

Figure 4-5

and indicates that the TACAN receiver is disconnected from the ID-249 course indicator and course and glide slope deviation indications are from the ILS equipment.

Operation of ILS

1. ON-OFF-VOL switch - ON.
2. Desired localizer frequency - Select.
3. Volume - Adjust.
4. Localizer station - Identify.
5. Front course heading - Select.
6. ILS light - Check ON.
7. Glide slope and localizer warning flags - Check not visible.

DF-203 ADF RECEIVER

The DF-203 ADF radio receiver is an automatic or manual direction finder and a low and broadcast range aural receiver. The equipment consists of a radio receiver, a control unit, a flush sense antenna, a flush fixed loop antenna, a BDHI and the connecting cabling, antenna coupler and a quadrantal error corrector. The receiver covers a frequency range of .19 to 1.75 megacycles in three bands. Power for the equipment is furnished by the essential dc bus and the 26-volt instrument transformer.

ADF Control Panel

The ADF control panel is installed on the right console of the cockpit. The controls are described below.

Function Switch

The function switch is the larger of the two concentric knobs on the inboard side of the panel. The labeled positions are OFF, ADF, ANT and LOOP. In the OFF position the equipment is de-energized. In the ADF position the equipment functions as an automatic direction finder with a continuous indication of the bearing to the radio station shown on the BDHI if the AN/ARC-50 is not operating in the DF mode. In this position both the sense and loop antennas are connected to the receiver. In the ANT position, received signals are obtained only from the sense antenna and the equipment functions as a conventional aural radio receiver. In the LOOP position received signals are obtained only from the loop antenna and the equipment functions as a manual direction finder to enable the pilot to determine the bearing to the radio station by aural null procedures.

Band Selector Switch

The band selector switch is the larger of the concentric knobs located in the outboard side of the control panel and is used to select the desired frequency band. The correct frequency scale will also appear in the frequency indicator window for the band selected as follows:

Band Frequency	Coverage
.19 - .40 MC	190 - 400 KC FAA Low Frequency Band
.40 - .84 MC	400 - 840 KC International Distress Frequency and Lower Broadcast Band
.84 - 1.75 MC	840 - 1750 KC Upper Broadcast Band

Tuning Control

The tuning control is the smaller of the outboard concentric knobs and tunes the receiver within the frequency band selected. The tuned frequency is indicated on the scale of the frequency indicator. The control is also rotated slightly for maximum reading on the tuning meter.

Loop Control

The control labeled LOOP is used to accomplish the electrical equivalent of rotating the loop (gonio) antenna. The control is labeled L and R and the left or right rotation effect will be apparent in the headset and the tuning meter. The speed of the rotating effect may be slowed by turning the loop control approximately half way to the L or R labeled position.

Gain Control

The gain control is the smaller of the inboard concentric knobs and is provided to adjust the audio level of the receiver.

BFO Switch

The BFO switch when in the BFO position provides a beat frequency oscillator to aid in tuning the receiver or to receive coded transmissions.

Bearing, Distance, Heading Indicator (BDHI) No. 1 Needle

ADF bearing indication is provided by the No. 1 needle of the BDHI when the BDHI No. 1 needle selector switch is in the HF/UHF (aft) position and the AN/ARC-50 ADF is not operating. Refer to BDHI, this section.

NORMAL OPERATION

Operation of the ADF Receiver as a Conventional Radio Receiver

1. Function switch - ANT.
2. Band selector switch - Select desired band.
3. Tuning control - Rotate to desired frequency and adjust for maximum reading on the tuning meter.
4. Volume - Adjust as desired.
5. The BFO switch can be used to tune in continuous wave signals or to zero beat modulated signals.

Operation of the ADF Receiver as an Automatic Direction Finder

1. Tune receiver as above and positively identify the station.
2. Function switch - ADF.
3. Tuning control - Tune for maximum signal reading on tuning meter.
4. BDHI No. 1 needle selector switch - ADF (aft).
5. Read bearing to station on BDHI No. 1 pointer.

Operation of the ADF Receiver as a Manual Direction Finder (Aural Null)

1. Tune receiver as above and postively identify the station.
2. Tuning control - Tune for maximum signal reading on tuning meter.

3. BDHI No. 1 needle selector switch - ADF (aft).

4. Function switch - Loop.

5. Loop control - R or L, as necessary, to acquire null.

NOTE

If the AN/ARC-50 ADF function is operating, the No. 1 BDHI needle will remain connected to the UHF equipment.

TRANSPONDER (IFF) - 914-X-1

The 914-X-1 transponder provides reception, detection, decoding, encoding and transmission of signals in the IFF Mark X (SIF) system and has a locally installed MODE X discrete operating function. The transponder will also recognize a Mode 4 interrogation; however, the set will not decode or encode a reply without accessory equipment. Any one of numerous coded replies available for Modes 1, Mode 3 or X can be selected by rotating the appropriate selector switches on the panel. The set is capable of transmitting an emergency reply regardless of the interrogation mode. A provision is also incorporated to identify position of the aircraft. Power for the set is furnished by the essential dc bus. Addition of the Mode X capability deletes the Mode 2 function from the transponder.

TRANSPONDER (IFF) CONTROL PANEL

The transponder control panel is installed on the upper left console. The panel contains two code selectors for Mode 1 and Mode 3/X codes, Mode 1 and Mode 3 toggle switches, an I/P switch, IFF power selector switch and an emergency switch bar.

Power Switch

The IFF power switch has three positions: Off, LO, and ON. When the switch is placed in the LO position only local (strong) interrogations are recognized and answered. With the switch in the ON position, there is full sensitivity for recognition and reply. The IFF power switch activates Mode X when in the ON or LO position. Response to Mode 1 and Mode 3 interrogations depends on the position of the Mode 1 and 3 toggle switches. When the Emergency switch bar is up, the power switch is forced to the ON position. A 30 second time delay is incorporated in the power switching before the equipment is operative.

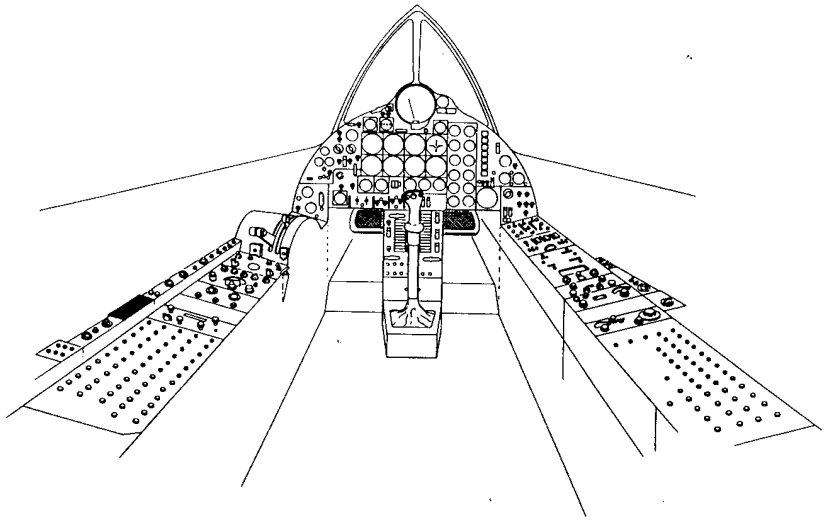
Mode Switches

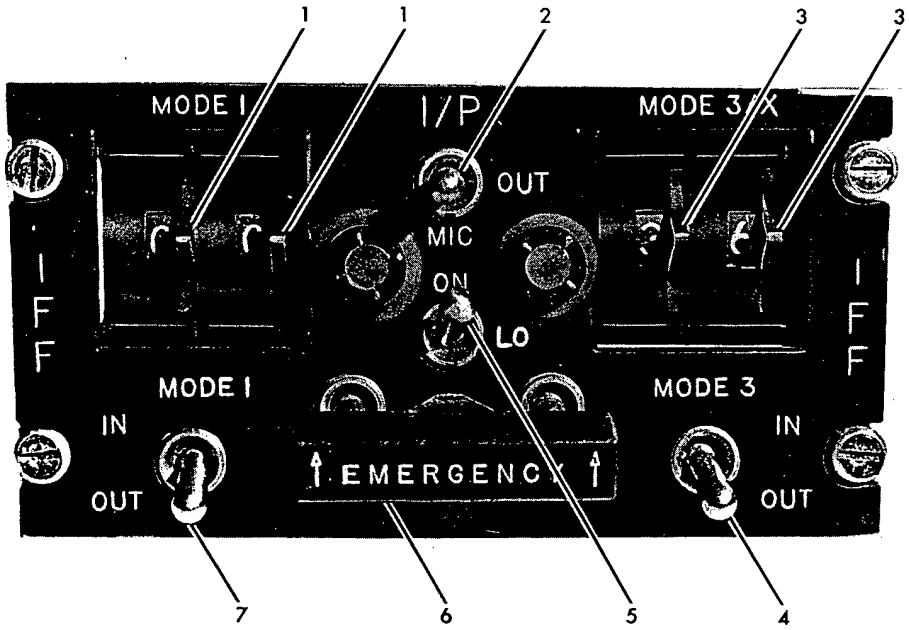
Two two-position mode switches, one for Mode 1 and one for Mode 3, control transmission of Mode 1 and Mode 3 replies. Correctly coded interrogations will be answered when a mode has been made active by selecting the IN position. When a Mode 1 or Mode 3 switch is in the OUT position, that mode is not active and does not transmit upon interrogation except in Emergency. Mode X is active at all times when the power switch is in the ON or LO position and is not affected by the Mode 1 or Mode 3 toggle switch positions.

Code Selectors

Two rotating type code selectors are provided. The code selector for Mode 1, consists of two rotary digital indicating switches. The first digit window will indicate 0, 1, 2, 3, 4, 5, 6, or 7. The second digit window will indicate 0, 1, 2, or 3. The Mode 3/X code selector will indicate 0, 1, 2, 3, 4, 5, 6, or 7 for each digital window. The mode 3 code selection also controls the Mode X code transmission.

IFF/SIF CONTROL PANEL





1 MODE 1 CODE SELECTORS
2 IDENTIFICATION OF POSITION (I/P) SWITCH
3 MODE 3/X CODE SELECTORS
4 MODE 3 SWITCH
5 IFF POWER SWITCH
6 EMERGENCY SWITCH BAR
7 MODE 1 SWITCH

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Figure 4-6

Emergency Switch Bar

The emergency switch bar, when placed in the EMERGENCY up position, operates two toggle switches that controls emergency response and also pushes the IFF power switch to the ON position if it is in the off or LO position. When the emergency bar is in the up position an emergency indicating pulse group (code 7700) is transmitted on Mode X each time an interrogation is made on Mode X. Mode 1 and 3 are also turned on by the emergency bar irrespective of the position of the Mode 1 and 3 In-Out switches. In the EMERGENCY position Mode 1 will respond on the code selected but Mode 3 will respond on code 7700 irrespective of code selected.

NOTE

The ground radar scope indication from this transponder is coded in a different manner than the normal AN/APX-46 transponder.

Identification of Position Switch

The identification-of-position (I/P) switch is used to control transmission of I/P pulse groups. The switch has three positions; MIC, OUT and a spring-loaded I/P position. When the switch is momentarily in the I/P position, the I/P timer is energized for 30 seconds. If an interrogation is recognized on any active mode within this 30 second period, I/P replies will be made. When the switch is in the OUT position, transmission of the I/P pulse groups is withheld. The MIC position is inoperative.

OPERATION OF THE IFF SYSTEM

1. Power switch - ON or LO.
2. Emergency bar - Down.
3. Mode 1 and Mode 3 IN-OUT switches - As required.

NOTE

Mode X operation is continuous when the power switch is in the LO or ON position. For secure IFF operation, both the Mode 1 and Mode 3 toggle switches must be in the OUT position.

4. I/P switch - As required.
5. Code selectors - As required.

To make an emergency response to Mode 1, Mode 3 and Mode X interrogations:

6. Emergency bar - Push up.

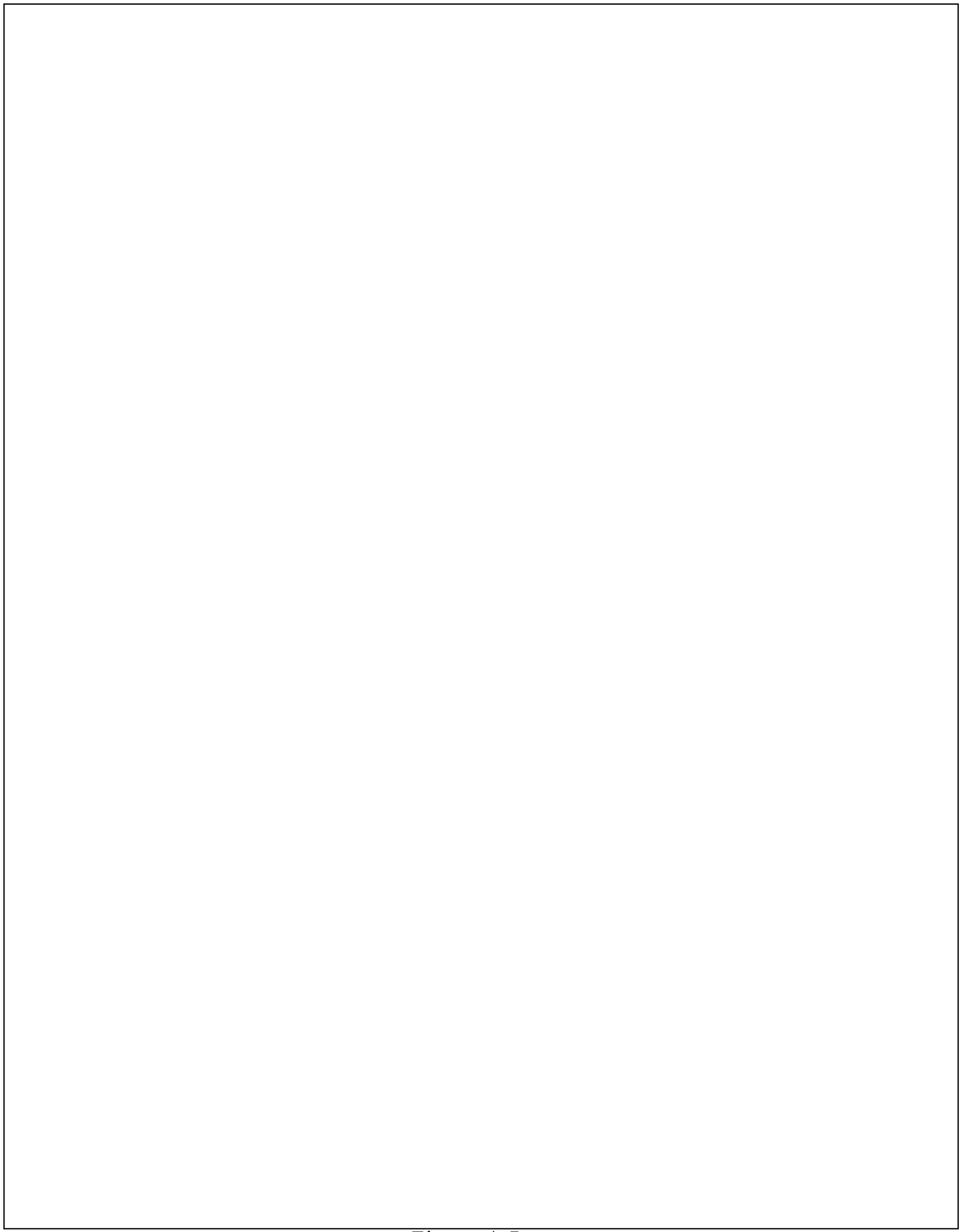
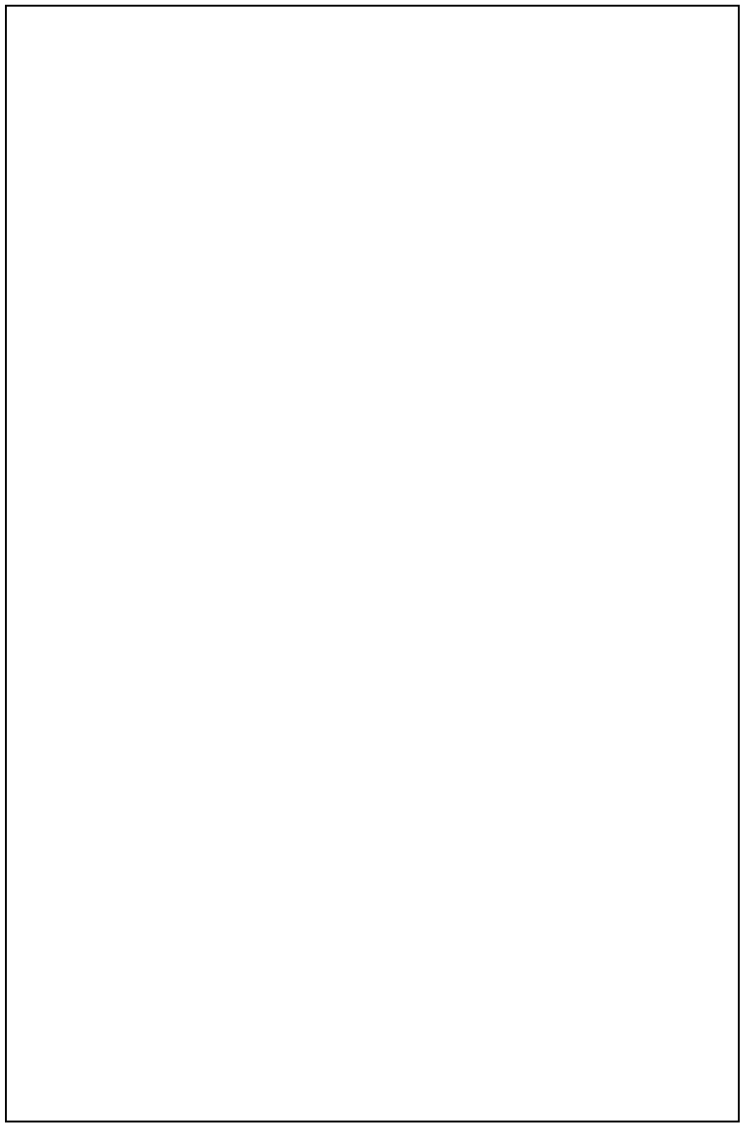


Figure 4-7



AN/AIC -18 INTERPHONE

An AN/AIC-18 interphone control panel is located behind the pilot's seat. The panel contains a Call knob, Normal-Aux-Listen switch and a Volume control knob. Due to the location of the panel, the volume control must be preset prior to flight. No On-Off switch is provided and the equipment is operative whenever the essential dc bus is energized.

Call Knob

The call knob is inoperative.

Normal-Aux-Listen Switch

The Normal-Aux-Listen switch has two positions; NORMAL and AUX LISTEN. The NORMAL position allows all audio signals to pass through the AN/AIC-18 amplifier. The volume control knob on the AN/AIC-18 panel is used to adjust the audio signal intensity. The AUX LISTEN position bypasses the amplifier and audio intensity must be adjusted with the individual equipment volume control. The switch is safety-wired to the NORMAL position.

Microphone Switch

A transmitter-interphone mircophone switch is installed on the control stick. The momentary TRANS position (up) is used for UHF, or HF depending on the position of the microphone selector switch on the left console. The INPH position (down) provides interphone operation for communication with the ground crew and A/R interphone during refueling contact. This position is also used to activate the dictet recorder for pilot comments if recorder switch is in RECORD position.

Throttle Microphone Button

A microphone button is provided on the right throttle for use during taxi, takeoff and landing when the nose steering must be held engaged. This is a pushbutton switch which must be held down for radio transmission.

Communication Selector Switch

A three position rotary switch labeled **COMM** located on the left console selects the radio or interphone to which the microphone output will be connected. In the HF position the microphone output will be connected to the 618T HF radio. This position also automatically provides ARC 50 ac inverter power to the HF when the left generator is below correct frequency. In the UHF (center) position the microphone output is connected to the ARC 50 UHF radio. The right position labeled SIL disconnects the microphone from all transmitters to prevent inadvertent transmissions. The microphone connection to the interphone system and to the tanker is through the refueling probe and is accomplished by using the normal INTPH position.

IFR Volume Control

The IFR volume control is located on the upper left console and when turned clockwise increases the interphone audio volume.

LIGHTING EQUIPMENT

EXTERIOR LIGHTING

Beacon and Fuselage Lights

Two retractable lights are located near the midpoint of the fuselage. One is on the top of the fuselage and the other on the bottom. When the lights are retracted they are flush with the fuselage contour and when turned on will show a white light from above and below. The lights will extend approximately two inches and, when in this position and turned on, the red lights and reflectors rotate at 45 rpm, giving the effect of 90 flashes per minute. The lights are powered by the essential dc bus and the rotating and retracting mechanism is powered by the No. 1 inverter.

Beacon and Fuselage Light Switch

This three position switch is located at the forward end of the upper left console. In the center OFF position the lights are retracted and turned off. In the BCN LTS (forward) position the lights extend, illuminate and rotate. Extension and retraction time is approximately 30 seconds. In the FUS LTS (aft) position the white lights illuminate in the retracted position.

Landing and Taxi Lights

A 1000 watt landing light and a 450 watt taxi light are mounted on either side of the nose gear strut. Power for the lights is furnished by the left generator bus.

Landing and Taxi Light Switch

A luminous (3 dot) switch located on the left side of the instrument panel operates the landing and taxi lights. The switch has three positions; LAND (up), TAXI LT (down) and OFF (center).

INTERIOR LIGHTING

Cockpit Lighting System

The instruments and consoles are illuminated with edge and post lighting. In addition, two flood lights are provided on each side of the cockpit and a utility spotlight is mounted above each console. The spotlights are detachable and may be moved about the cockpit. Rheostats on the aft end of the spotlights are used to vary their intensity. Each spotlight is provided with a pushbutton switch which enables the pilot to obtain maximum brillance without use of the rheostat. Red or white light may be selected by rotating the lens color selectors on the front of the lights. Power for the instrument and console lights is furnished by the left generator bus. Power for the floodlights and utility spotlights is furnished by the essential dc bus.

Cockpit Light Switches

Rheostat type instrument and panel light switches are located on the cockpit left console. Ten rotary positions are available to vary light intensities from OFF to BRT. The floodlight switch located on the outboard side of the right console varies the intensity of both lights from OFF to BRT.

FLIGHT RECORDER

An automatic, continuously operating flight recorder is normally mounted in the right chine of the aircraft to record airspeed, altitude, vertical acceleration, heading and elapsed time on an aluminum foil tape. The recorder has its own pitot static system which may also be used as an alternate for the normal pitot-static system. Heading information for the recorder is furnished by the FRS compass system. Ac electrical power from the No. 3 inverter is used to keep a spring motor wound so that all in-

FLIGHT RECORDERS

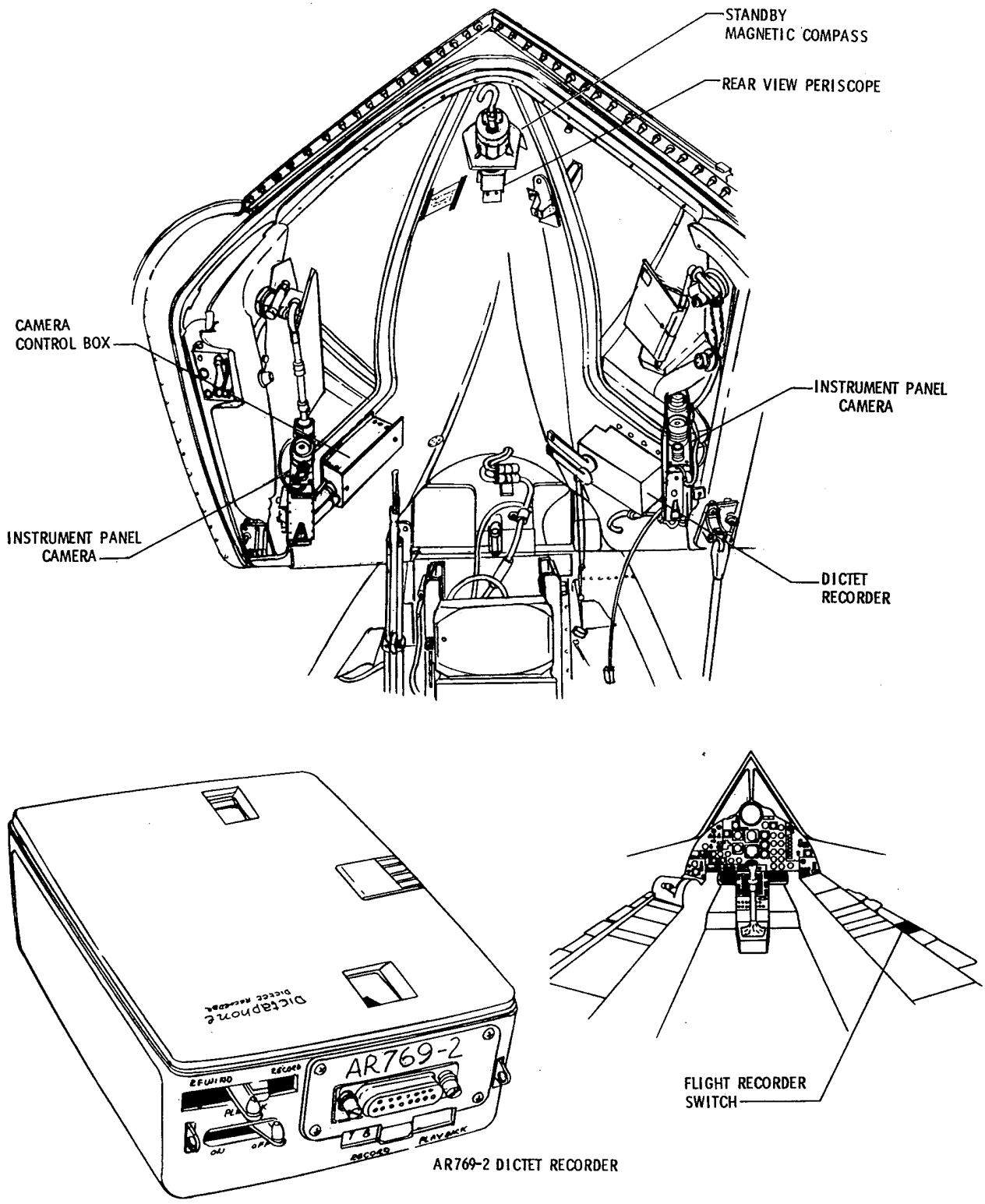


Figure 4-7

formation except heading will be recorded for approximately 10 minutes after electrical power is interrupted. The recorder pitot static system remains available as an alternate airspeed system when the recorder is not installed.

Flight Recorder Switch

This toggle switch is located outboard of the right console and has labeled positions ON and OFF.

Pitot Pressure Selector Lever

This lever is located on the forward right side of the cockpit wall. It is normally safety-wired in the NORMAL position. In the event of a malfunction of the normal pitot static position system, the lever may be moved to the ALT position. This furnishes pitot static pressure from the flight recorder system to the aircraft flight instruments and ejection seat speed sensor.

DICTET TAPE RECORDER

The Dictet Tape Recorder is located on the left side of the canopy. It has two levers; one labeled REWIND, RECORD and PLAY-BACK and one labeled ON and OFF. It is preset prior to flight and is activated by the interphone switch. The tape is in motion only when the interphone switch is used and provides up to two hours of recording time.

AUTOPILOT SYSTEM

The autopilot portion of the AFCS relieves the pilot from manual aircraft control and provides a means for automatic navigation when coupled to the output of the INS. The autopilot functions are:

1. Pre-engage synchronization.
2. Attitude hold in roll and pitch.
3. Pitch and turn wheel inputs.
4. Automatic pitch trim.
5. Heading hold.
6. Mach or KEAS hold.
7. Auto navigation.

The autopilot is optimized for basic mission cruise speed and altitude but may be used at other flight conditions.

There are no restrictions on use of the roll autopilot. The autopilot authority is limited to prevent severe maneuvers due to an autopilot malfunction. The maximum pitch authority below 50,000 feet is 1.3^{o} up and down elevon. Above 50,000 feet the maximum authority is 2.4^{o} up and down elevon. The maximum roll authority is 4° differential elevon. The autopilot signals are summed with SAS signals and produce control surface motion through the SAS electronics and servos.

CAUTION

Do not use the autopilot when using BUPD.

Autopilot control movement of the elevons is not reflected in control stick motion. Automatic pitch trim is operative when the autopilot pitch channel is engaged. The slow speed pitch trim motor operates to correct for long period pitch trim changes and there should be no pitch transient at disengagement. Preengage synchronization of autopilot pitch and roll trim operates when the pitch or roll channels are disengaged.

Autopilot and Attitude Reference Selector Switch

This selector switch is located on the right console outboard of the INS control panel. The switch has three positions; FRS (forward), OFF (center) and INS (aft). In the FRS position directional signals from the FRS compass and attitude signals from the FRS pitch and roll gyros are supplied to both the autopilot and the attitude indicator. In the OFF position the autopilot can not be engaged but pitch and roll signals from the FRS are furnished the attitude indicator. In the INS position the INS stable platform furnishes pitch and roll signals to both the autopilot and the attitude indicator and true heading directional signals are furnished to the autopilot. In the OFF and FRS positions inverter power for autopilot, air data computer, and TDI indicator is furnished by the No. 1 inverter bus. In the INS position inverter power for these items is transferred to the No. 3 inverter bus. This switching provides the same phase of power for the autopilot and the air data computer as that provided for the FRS or INS.

CAUTION

Avoid excessive switching between FRS and INS positions as the resulting power transients tend to degrade INS accuracy.

AUTOPILOT CONTROLS AND INDICATORS

The autopilot controls and indicators are on the SAS panel located on the right console. The control stick is equipped with control stick command and emergency disengage switches. The circuit breakers are on the right and center console circuit breaker panels. Power is from the essential dc bus and the No. 3 or No. 1 inverter.

Autopilot Pitch Engage Switch

A two-position pitch engage switch is located on the inboard side of the autopilot control panel. In the ON (fwd) position, the pitch autopilot is engaged in the attitude hold mode.

NOTE

At least one active SAS pitch channel must be engaged and bank angle must be less than 50° before the pitch autopilot can be engaged.

The switch is held in the ON position by a solenoid. The pitch channel may be disengaged by placing the switch to the OFF position, by using the disengage switch on the control stick, or by turning the autopilot selector switch OFF.

Autopilot Pitch Trim Synchronization Indicator

The pitch trim synchronization indicator shows the amount of pitch signal existing prior to engagement. An up or down displacement of the needle indicates the direction of the transient which will occur when the pitch channel is engaged.

NOTE

The pitch trim synchronization needle will normally be centered within one needle width. Engagement of the autopilot pitch channel with more than one needle width of misalignment is not recommended.

Autopilot Pitch Control Wheel

A serrated pitch control wheel is located just forward of the pitch engage switch. The wheel is used to make pitch attitude corrections when engaged in the attitude hold mode. Forward rotation of the wheel commands nose down and aft rotation commands nose up. Pitch attitude changes 1° for 20° of wheel rotation.

Autopilot Roll Engage Switch

A two-position roll engage switch is located on the autopilot panel. In the ON (fwd) position, the roll autopilot is engaged in the attitude hold mode.

NOTE

At least one SAS roll channel and one active SAS yaw channel must be engaged before the roll autopilot can be engaged. Bank angle must be less than 50°.

The switch is held in the ON position by a solenoid. Autopilot signals are supplied by either the FRS or the INS, depending on the position of the autopilot selector switch. The roll channel may be disengaged by placing the switch to the OFF position, by using the disengage switch on the control stick or by turning the autopilot selector switch OFF.

Autopilot Roll Trim Synchronization Indicator

The roll trim synchronization indicator shows whether or not a roll signal exists prior to engagement. The needle always deflects to the right and does not indicate the direction of the transient which will occur at engagement.

NOTE

Roll engagement is not recommended if the needle is deflected to the side of the dial, indicating a hardover signal.

Autopilot Turn Control Wheel

A serrated turn control wheel is located on the autopilot panel. It allows the pilot to make roll attitude corrections when engaged in the attitude hold mode. Right rotation of the wheel commands right roll and left rotation commands left roll. Roll attitude changes 1° for 10° of wheel rotation. The pilot can command up to 50° of bank angle in the attitude hold mode. Above 50° of bank the roll autopilot automatically disengages to prevent the steady pitch rate from bottoming the pitch servos, as this would eliminate pitch damping capability.

Mach/KEAS Hold Switch

A Mach/KEAS hold switch is located on the inboard side of the autopilot panel. The Mach or KEAS hold mode is engaged when the switch is in the respective position, provided the pitch autopilot is engaged. The switch is held in by solenoid action. The autopilot then controls the pitch attitude to maintain the same Mach number or KEAS that existed at the time of engagement. When the Mach or KEAS hold is engaged, the pitch attitude hold is discontinued and the pitch control wheel setting should not be changed. Mach hold reference signals are supplied to the autopilot from the air data computer.

CAUTION

Do not use the Mach/KEAS hold mode when the TDI indication is known or suspected to be inaccurate.

Auto Nav Switch

An AUTO NAV switch is located between the Mach/KEAS hold and heading hold switches. The auto nav mode is engaged when the switch is in the ON position provided the

roll autopilot is engaged. The switch is held on by solenoid action. Steering signals are furnished by the INS and the autopilot controls the aircraft to follow the selected great circle course. If the heading hold mode was previously engaged, it will be disengaged when auto nav is selected. The bank angle is limited to 30° in the auto nav mode.

Heading Hold Switch

A heading hold switch is located on the outboard side of the autopilot panel. The heading hold mode is engaged when the switch is in the ON position provided the roll autopilot is engaged. The switch is held on by solenoid action. Heading signals from either the FRS compass or INS control the roll axis of the aircraft to maintain the heading existing at the time of engagement. Heading hold may be engaged while in a bank. The autopilot will roll the aircraft to a wings level attitude and lock on the heading at time of engagement. The heading hold and auto nav switches are interlocked to permit only one to be engaged at a time. The auto nav switch will be released when the heading hold switch is on.

NOTE

When in heading hold mode the drift rate is similar to a free gyro rate and will be approximately 8° per hour increasing to 15° per hour in polar areas.

Control Stick Command Switch (CSC)

A control stick command switch is located on the right side of the control stick. While the switch is depressed, both the roll and pitch autopilots revert to the preengage synchronization mode. This allows attitude and heading to be changed without opposition from the autopilot. When the switch is released, both the roll and pitch axes are engaged in the attitude hold mode, regardless of the mode that was engaged prior to depressing the CSC switch.

Autopilot Emergency Disengage Switch

A trigger-type switch located on the forward side of the control stick will disengage the autopilot completely. The autopilot is not reengaged when the switch is released.

NORMAL OPERATION

Engagement

The autopilot is placed in normal operation as follows:

1. Check SAS engaged, recycle lights out.
2. Check pitch and roll trim preengage synchronization indicators aligned.
3. Pitch and roll engage switches ON. These switches may be engaged together or separately as operation of the two is completely independent.

NOTE

Bank angle must be less than 50°.

4. Mach/KEAS hold switch - OFF.
5. Heading hold - As desired.

If Auto Nav is required:

6. Autopilot selector switch - INS.
7. Auto Nav switch - ON.

WARNING

Do not operate manual roll or pitch trim when the autopilot is engaged.

Disengagement

To change attitude or heading:

1. CSC switch - Depress.

After attitude and/or heading change:

2. CSC switch - Release.
3. Mach/KEAS hold switch - OFF.
4. Autopilot selector switch - As desired.
5. Heading hold or auto nav - As desired.

To disengage autopilot:

1. Autopilot disengage switch - Press.

or

2. Pitch and roll engage switches - OFF.

or

3. Autopilot selector switch - OFF.

Mach/KEAS Hold Engagement

Prior to engagement of Mach/KEAS hold the pilot will accomplish the following:

1. Attain desired KEAS, altitude and Mach number.
2. Throttle - As required.
3. Trim - As required.
4. Autopilot pitch - ON.
5. Maintain stabilized KEAS or Mach conditions for 60 seconds.

NOTE

Do not engage Mach/KEAS hold during turns or other maneuvers as undesirable transient will be produced. Mach/KEAS hold may however be left engaged during turns if already on.

6. Mach/KEAS hold switch - ON as desired.

CAUTION

The pitch control wheel must not be used during Mach/KEAS hold operation to prevent rapid pitch motion or disengagement.

To minimize altitude excursions during turns:

7. Throttle - Gradually advance during roll in.
8. Throttle - Gradually retard during roll out.

If changing flight conditions, retrim when power settings are changed more than 5%:

9. Mach hold - OFF.

NAVIGATION EQUIPMENT

FLIGHT REFERENCE SYSTEM

The Flight Reference System and SR-3 compass is a navigation system which supplies information for indication and control of aircraft heading and attitude. It can be used independently of the Inertial Navigation System. The FRS consists of a flight reference platform, turn rate servo, induction compass transmitter, heading and attitude couplers for the autopilot, control panel, and the rotating compass cards of the BDHI. Either a directional gyro (DG) or magnetic slaved (MAG) mode can be selected to provide directional reference to all latitudes. In either mode:

Heading information is furnished -

(1) To the autopilot when the autopilot selector switch is in the FRS position.

(2) To the BDHI compass card when the autopilot selector switch is in the FRS position.

Attitude information is furnished -

(1) To the autopilot when the autopilot selector switch is in the FRS position.

(2) To the attitude indicator when the autopilot selector switch is in the FRS position.

Directional Gyro Operating Mode

When in the directional gyro mode of operation, the FRS is free of magnetic influence and operates as a directional gyro, indicating heading relative to an arbitrary reference heading selected by the pilot. It may be used at all latitudes, but is most useful when the magnetic field is weak or distorted or when navigating in the polar regions. It is more reliable than the magnetic mode at latitudes near the magnetic poles. When in the DG mode, with proper hemisphere and latitude selection made on the control panel, the gyro is made to precess to compensate for apparent gyro drift due to earth rate at the selected latitude.

Magnetic Slaved Operating Mode

When operating in the magnetic slaved mode, the FRS is basically a gyro stabilized compass slaved to the induction compass transmitter. This mode provides heading without northerly turning error or oscillations. It is less reliable than the DG mode at latitudes near the magnetic poles as the MAG mode is subject to severe magnetic distortion near those poles.

FRS COMPASS CONTROL PANELS

The COMPASS controls are located on the right console, immediately forward of the circuit breaker panel. The panel contains a function selector switch, set heading knob, latitude selector knob and indicator window, synchronization indicator, malfunction indicator, hemisphere selector switch, and a take command button.

Take Command Button

A combination button and light on the control panel provides for transfer of control of the FRS by depressing the button and observing the green light. It is not operative on this installation.

Function Selector Switch

The two position function selector switch allows selection of either a magnetic heading or a free gyro reference. The DG (right) position selects directional gyro mode; the MAG (left) position selects the magnetic slaved mode.

Hemisphere Selector Switch

The Hemisphere Selector switch must be set to correspond to the hemisphere in which the aircraft is located. The left (S) position is used when in southern latitudes. The right (N) position is selected for northern latitudes.

Latitude Selector Knob and Indicator

The latitude selector knob may be rotated to select and display latitude in degrees and tenths of degrees in the indicator window. The knob is used only in the DG mode. The latitude setting is used in the DG mode to correct the directional gyro for the apparent drift due to the earth's rotation. For accurate operation of the FRS in the DG mode, the latitude indicator must be set to coincide with the actual latitude of the aircraft at all times.

NOTE

The proper corrections will not be made if the hemisphere selector switch setting does not correspond to the hemisphere in which the aircraft is located.

Malfunction Indicator

A malfunction indicator is provided which monitors the power supply and other prime system functions. Any deviation of the monitored functions from normal operation will cause the indicator to display three white triangles.

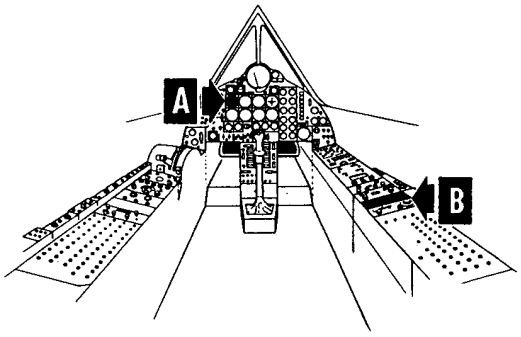
Heading Set Knob and Synchronization Indicator

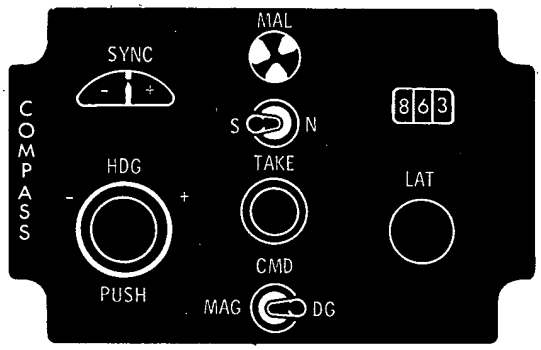
The heading set knob provides a means to fast slave or synchronize the rotating compass card of the BDHI to the correct magnetic heading or desired gyro heading, depending on the position of the function selector switch. When in the MAG mode, initial synchronization with the compass transmitter heading is obtained by pushing and holding the heading set knob until the synchronization indicator becomes centered. In the DG mode, the heading is set to the desired initial indication by pushing and turning the heading set knob. Turning the heading set knob clockwise produces an increasing heading, with the rate of change being indicated by the deflection angle of the synchronization indicator.

FRS OPERATION

1. Function selector switch - MAG or DG, as desired.
2. Hemisphere selector switch - Set to correspond with aircraft location in Northern (N) or Southern (S) hemisphere.
3. Latitude selector knob - Set to correspond with existing latitude when DG mode selected.
4. Heading set knob - Synchronize or slave to heading desired.
5. Autopilot selector switch - FRS.

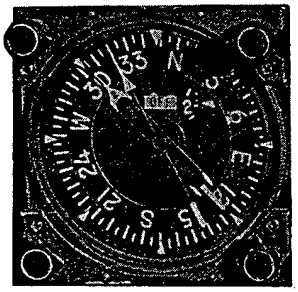
FLIGHT REFERENCE SYSTEM (FRS) COMPASS PANEL AND BDHI





DETAIL B

FLIGHT REFERENCE SYSTEM CONTROL PANEL



DETAIL A

BEARING DISTANCE HEADING INDICATOR (BDHI)

F200-65(b)

Figure 4-9

Slaving

The normal slaving rate of the FRS is about 1-1/2° per minute. The gyro may be as much as 180° from the proper heading when the compass system is energized before takeoff, and as much as 1-1/2 hours would be required to slave to the correct heading at normal slaving rates. Manual fast slaving is provided by pushing and holding the heading set knob depressed. This increases the slaving rate to 720° per minute and will correct a 180° error in 15 seconds.

If the compass is properly slaved before takeoff, no in-flight manual fast slaving is required unless free directional gyro operation is selected. When operating in the free gyro mode, the desired heading can be established by using the heading set switch.

CAUTION

The roll autopilot must be disengaged before attempting manual slaving when the FRS is being used as a heading reference.

FRS OPERATING CHARACTERISTICS

The SR-3 flight reference platform consists of a single axis directional gyro which is attitude stabilized by a two axis vertical gyro. A compass transmitter is provided which establishes the directional reference while in level flight by detecting aircraft heading with respect to the horizontal component of the earth's magnetic field. When the system is operated in the magnetic mode, the directional gyro is slaved to the compass transmitter at a rate of 1-1/2 degrees/minute. When operating in the directional gyro (DG) mode, the compass transmitter signal is disabled and the heading reference is established by the directional gyro operating as a free gyro (except for earth's rate latitude correction). Electrolytic gravity sensors are used in conjunction with pitch and roll torquer motors to erect the attitude gyro to the local vertical. During periods of acceleration or deceleration along the flight path, heading and pitch attitude errors can be introduced due to the following effects:

a. The pendulously supported compass transmitter is displaced from the horizontal plane and becomes sensitive to the vertical component of the earth's magnetic field. This results in an erroneous heading reference. The magnitude of this error is a function of aircraft heading, transmitter tilt angle and the relative magnitude of the vertical field component. This error is introduced into the system at the normal slaving rate of 1-1/2 degrees/minute.

b. The pitch erection sensor, which is acceleration sensitive, provides an output signal to the pitch torquer causing it to precess the attitude gyro to a false vertical at a normal rate of 4 to 5 degrees/minute.

In order to minimize the above deficiencies, an electrolytic fore or aft acceleration cutout sensor (similar to the pitch erection sensor) is provided on the pitch gimbal of the attitude gyro. This sensor disables the pitch erection and slaving circuits when a threshold setting of .065 g along its sensitive axis is exceeded. However, operating as a free vertical gyro, it is subject to an apparent drift from the vertical due to the effect of the earth's profile and earth's rotation. These effects, coupled with the gyro free drift rate of 15 degrees/hr, results in a total drift from the vertical of about 1 degree/min. This displacement of the attitude gyro causes a gravity component to appear along the sensitive axis which acts as a bias to the horizontal acceleration signal (.065 g) which initiates slaving and pitch erection cutout. When the

bias signal acts in opposition to the sensed acceleration signal the effective value may drop below the .065 g threshold, thereby restoring pitch erection and slaving while the aircraft is still accelerating. The attitude gyro will then erect to a false vertical at the normal erection rate and the compass transmitter will precess the directional gyro to a false heading as determined by the transmitter tilt angle. When the attitude gyro drift exceeds 3-1/2 degrees, and the bias signal acts to aid the sensed acceleration signal; the system will maintain the cutout condition for an indefinite period after aircraft acceleration has ceased. In order to prevent this condition, the system is designed to limit pitch erection cutout to a maximum period of 4 minutes independent of acceleration.

In operational use the SR-3 system performs in the manner described above during periods of prolonged acceleration such as during acceleration-climb to supersonic cruise speed after takeoff and after refueling.

During climbout, pitch attitude and heading errors increase to about 6 degrees and 8 degrees respectively. These errors are eliminated at the normal rates when aircraft acceleration ceases. The heading error can be washed out very rapidly by pushing and holding the heading set knob on the FRS control panel until the synchronization indicator becomes centered. During aircraft turns in excess of 5 degrees/min the system operates as designed to cutout roll erection and slaving. Whenever a turn is initiated immediately following climbout, the accumulated climbout heading error will be increased and be maintained throughout the turn.

INERTIAL NAVIGATION SYSTEM (INS)

The inertial navigation system is self-contained and operates in all modes without the use of electromagnetic radiation or external references. The system consists of a gyro-stabilized platform, platform electronics, coupler and power supply, repeater and converter assembly, digital computer and computer power supply, control panels, and distance-to-go, groundspeed, and a direction indicator.

In operation the system displays present position, ground speed and the direction and distance to go to any of 42 preselected positions as continuous readouts. When operated in autopilot AUTO NAV, and INS STORED AUTO mode, the aircraft will be steered automatically to each point in the flight plan sequentially, with no pilot action required. If the flight plan is being flown in sequence in the STORED AUTO mode, the destination select light will illuminate if the destination displayed on the destination select panel does not agree with the destination towards which the aircraft is flying. This light is extinguished when the pilot sets the selector panel to the number of the stored destination being approached.

The destination select panel provides selection of destination numbered 0 through 41. The first 27 preselected positions are assigned to preplanned mission destinations, fix points, targets, rendezvous points, or other points occurring sequentially during the mission. The computer computes and stores the great-circle courses between each pair of these numerical points, and the aircraft will adhere to these great circle courses. Turns from one course to another will be made with bank angle optimized (with a maximum bank of 30 degrees) for the groundspeed and heading change required. The number 2 pointer of the BDHI will point toward the optimum path to follow to place the aircraft on the next course. If the pilot switches to a subsequent destination in STORED MANUAL

before completing the route segment he is on, the turn will be made in accordance with computer program directions.

Positions 27 to 41 provide ADF type steering for courses to these points and not meant to be used in the STORED AUTO mode. These positions are available for alternate destinations or may be used to employ an alternate flight path to a position included in the first 27. A sufficient number of alternate destinations is available to provide adequate coverage throughout the mission. Duplication of any of the first 27 positions in this group provides a steering indication on the BDHI number 2 pointer resembling that of ADF navigation, i. e., the pointer points directly to the next destination (within a 45 degrees needle deflection).

The basic reference of the inertial navigation system is provided by three single-axis accelerometers mounted at right angles to each other on a gyro-stabilized platform. The platform employs three floated integrating gyros, also mounted at right angles. The platform is initially aligned with a coordinate reference frame, represented by a plane tangent to the surface of the earth and oriented to any convenient azimuth at the point origin. The platform stable element is isolated from the airframe through a system of three gimbals which provide 360 degrees freedom of rotation in yaw and roll, and pitch angles of $\pm$ 60 degrees. All platform outputs are changed to digital form before entering the computer. In normal operation the platform also provides attitude outputs in analog form through resolvers and synchros to the autopilot, and the attitude indicator. Conversion of present position to latitude and longitude readout is accomplished continuously by the digital computer when in operational mode. Cooling air, necessary to the system, is supplied by the aircraft airconditioning and pressurization system. A self-contained heating system is incorporated in the platform to ensure that gyros and precision sensing components are maintained at temperature within an optimum operating range. The system is powered by the No. 3 inverter, the LH generator, and the monitored dc bus.

NOTE

Accuracy of INS information will be slightly degraded if pressure altitude data supplied by the air data computer is lost or is inaccurate.

The INS is controlled from two control panels, the navigation panel and the destination select panel. (See figure 4-10).

NAVIGATION PANEL

The navigation control panel, located on the right console, consists of a DEST/FIX selector switch, STORE pushbutton, MODE selector switch, FIX ADJ knob, two sets of geographic coordinate digital readout windows, labeled PRESENT POSITION and DESTINATION/FIX POSITION, a VARIABLE INPUT indicator labeled LAT and LONG, with thumbwheels for manual insertion of geographic coordinates and a switch for selection of N or S latitude. The controls and indicators are as follows:

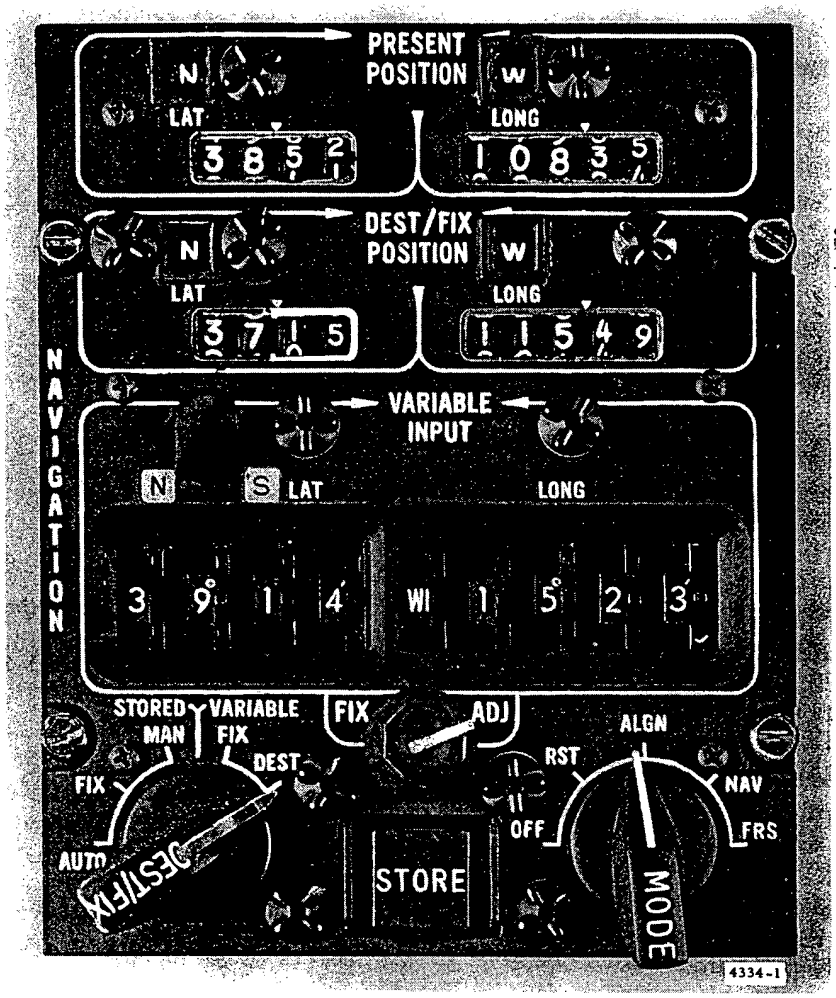
Mode Selector Switch

The mode switch is a rotary selector switch with five positions, labeled as follows: OFF, RST, ALGN, NAV, and FRS.

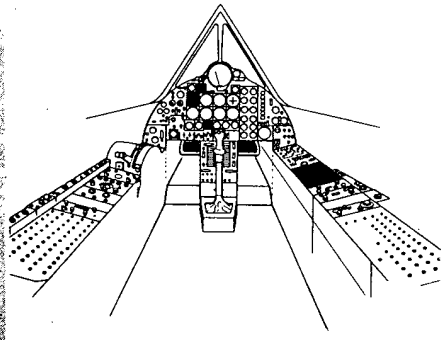
NOTE

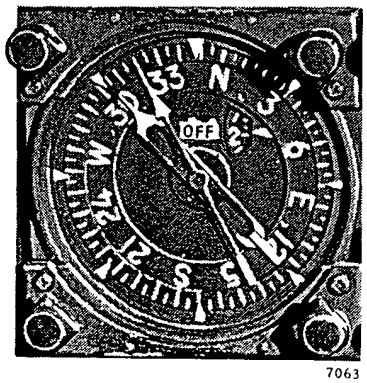
During flight the MODE switch must not be switched to any position other than NAV or FRS, otherwise the INS will be deactivated and will not function until the switch is moved through OFF, RST, and ALGN positions in conjunction with the ground operating equipment and normal INS preflight procedure.

INS PANEL AND INDICATORS

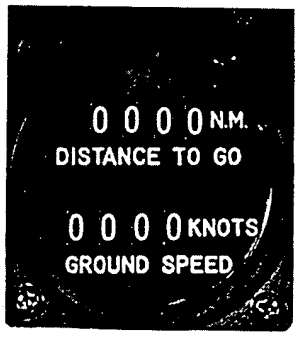


NAVIGATION CONTROL PANEL
(RIGHT CONSOLE)

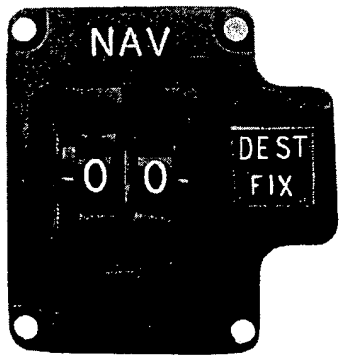




BEARING DISTANCE HEADING INDICATOR (BDHI)



DISTANCE TO GO/GROUND SPEED INDICATOR



DESTINATION SELECT PANEL

F200-34(f)

Figure 4-10

CAUTION

Do not move the MODE selector switch from the OFF position in flight if the INS has not been cycled from OFF to the NAV mode prior to flight. The INS system will be damaged.

RST Mode

The RST (reset) mode is used only on the ground during INS preflight when the platform has reached operating temperature. It permits the ground operating equipment (GOE) operator to check correct power switchover from ground to aircraft power, start the gyro spin motors, and make the computer ready for use.

ALGN Mode

The INS must be completely warmed up, stabilized, and aligned to a coordinate reference frame before it can be operated. This is necessary to minimize the drift of the stable reference platform once it is aligned to the coordinate reference frame. The complete warmup and alignment procedure at normal ambient conditions takes about 1-1/2 hours. During this period the destination loading operation is accomplished, normally by use of a punched tape. However, the coordinates of the present location and 42 destinations or targets may be set in manually by the VARIABLE INPUT thumbwheels and N-S selector and entered into the computer memory by pushing the STORE pushbutton for each position. After a period of gyro stabilization, the platform is torqued to the coordinate reference frame and the gyros are drift-trimmed. The two transverse horizontal accelerometers are used to sense the local vertical and their outputs are used in the servo loops that torque the platform and measure the amount of gyro drift. The presence of output signals from each accelerometer indicates that the platform is not level in that axis. While level aignment of the platform is being accomplished automatically, platform azimuth is aligned with a selected reference which is transferred to the platform by the ground operator. The platform is drift-trimmed at the reference points thus established, and the drift will be reduced to certain preestablished rates before the system can be operated. There is a detent between NAV and ALGN positions and the MODE switch cannot be moved either way between these two positions unless it is depressed.

NAV Mode

Switching to the NAV mode permits the GOE to be disconnected, and places the platform in the operational mode. The gyros are essentially memory devices that memorize the coordinate frame established. The system operates using these memorized coordinates to perform the navigation problem, and the accelerometers measure translations of the platform caused by movement of the aircraft. The accelerometer outputs are integrated once to provide velocity on each axis, and a second time to establish their displacement from the point of origin. These displacements (distances flown) are translated into geographical position coordinates by the computer. In addition to indicating position coordinates to the pilot, this position is also used to torque the platform to the local vertical and azimuth as the aircraft changes position. The coordinate frame thus rotates about the earth to retain its orientation on a plane tangent to the surface of the earth at the position of the aircraft.

FRS Mode

The flight reference system is the primary backup for the INS. Normally, the INS is operated with the switch in the NAV position, but the pilot may switch to the FRS position at any time to check FRS operation. When the switch is in the NAV mode, the BDHI rotating compass card indicates INS true heading; when in the FRS mode, the card indicates magnetic heading. When the switch is moved from the NAV to the FRS mode, the INS system continues to operate normally.

WARNING

If the INS should fail, the MODE switch should be moved to the FRS mode without delay in order to retain a heading indication on the BDHI display.

DEST/FIX Switch

The DEST/FIX (destination or fix) switch is a five-position rotary selector switch with positions as follows:

STORED

AUTO, FIX, MAN

VARIABLE

FIX, DEST

STORED AUTO. The INS will automatically sequence consecutively through the 42 prestored destinations as each is reached when the switch is in the STORED AUTO position.

STORED FIX. To use a prestored destination as a fix point, the switch is set to the STORED FIX position, the destination select panel is set to the desired destination number, and the STORE pushbutton is depressed when the fix point crosses the horizontal line on the periscope screen.

STORED MAN. To select any of the 42 prestored coordinate positions as a destination, out of the automatic consecutive sequence, the switch is set to the STORED MAN (manual) position, the destination select panel is set to the desired destination number, and the STORE pushbutton is depressed.

VARIABLE FIX. To use a variable (unstored) fix point as a point of reference, the switch is set to the VARIABLE FIX position, the VARIABLE INPUT thumbwheels are set to the fixpoint coordinates, and the STORE pushbutton is depressed when the fix point crosses the horizontal line on the periscope screen.

VARIABLE DEST. To select a variable (unstored) destination, the switch is set to the VARIABLE DEST (destination) position, the VARIABLE INPUT thumbwheels and N-S selector are set to the desired coordinates, and the STORE pushbutton is depressed.

FIX ADJ Knob

The fix-adjust knob, labeled FIX ADJ, controls a flight cursor on the periscope and is used to update the INS by means of visual fixes on known coordinate points. It is not necessary to fly directly over the fix point to obtain useful data. Viewing the fix point on the screen, the pilot positions the cursor with the FIX ADJ knob to coincide with the fix point as it crosses the horizontal reference line on the display. (Refer to discussion of fix-taking for further information.)

STORE Pushbutton

The STORE pushbutton is used to store in the computer memory either selected destination information or position information which has been selected by the VARIABLE INPUT thumbwheels and N-S selector. It also initiates the computations required to navigate to the coordinates selected.

CAUTION

Do not push this button unless a course change or fix is desired.

NOTE

The DEST/FIX pushbutton on the destination select panel is identical in function to the STORE button on the navigation panel. They may be used interchangeably.

N-S Hemisphere Selector Switch

The N-S selector switch may be placed in either N or S, depending in which hemisphere the desired destination or fix is located. This selector is only used in conjunction with the variable input thumb wheels to manually insert a destination or fix point in flight.

VARIABLE INPUT Indicator

The VARIABLE INPUT indicator has thumbwheels that are used to manually insert any desired reference coordinates into the system, thus giving the pilot added flexibility of operation in flight. (It is good practice to put the DEST/FIX switch in the VARIABLE DEST or VARIABLE FIX position prior to setting the coordinates in the indicator.) To insert variable destination coordinates into the system, select VARIABLE DEST on the DEST/FIX switch, then insert the desired destination coordinates with the VARIABLE INPUT thumbwheels; select desired hemisphere with the N-S selector and depress the STORE pushbutton. The DESINTATION/FIX POSITION indicator will read out the new coordinates immediately after the STORE button is depressed, and the INS will navigate the aircraft to the new destination using ADF type steering. Variable update fix coordinates are inserted in the computer in the same way as a destination, except that VARIABLE FIX is selected on the DEST/FIX switch.

PRESENT POSITION Indicator

The PRESENT POSITION indicator is set at the geographical coordinates of the flight origin site prior to takeoff. In flight it continuously indicates the coordinates of the aircraft position as computed by the INS.

DESTINATION/FIX POSITION INDICATOR

The DESTINATION/FIX POSITION indicator normally displays the latitude and longitude coordinates of the destination to which the INS is navigating. This display may be the coordinates of any selected destination from the 42 prestored positions, or the coordinates of any selected variable destination. This coordinate display normally changes at such times as the computer calculates a new course to a newly selected destination. For STORED MANUAL or VARIABLE DEST modes, this change will occur upon depressing the DEST FIX or the STORE pushbutton. For sequential or out of sequence destination selections in STORED AUTO mode, the destination coordinate display will change coincident with roll out to the new destination course. The minutes counter portion of the latitude display may also change whenever a fix is taken. When either a STORED FIX or VARIABLE fix is taken; the calculated cor-

rection (in nautical miles) is displayed on the latitude minutes display, without changing longitude, or the degrees portion of latitude on the DESTINATION/FIX POSITION indicator. The portion of the latitude display used for the fix distance indication is blocked off in white on the indicator (see figure 4-10). The calculated fix correction is displayed up to a maximum value of 59 nautical miles whether position is updated or whether the fix is rejected. The calculated fix correction will continue to be displayed until another fix is taken, or until a new destination is selected and displayed. When a new destination is selected, the latitude minutes counters will revert to a display of destination latitude until such time as another fix is taken.

DESTINATION SELECT PANEL

The destination select panel, labeled NAV, is located on the instrument panel. The panel has a two-place digital counter, controlled by thumbwheels, and a self-illuminated pushbutton switch which read out DEST FIX when lighted. The number of a stored destination or fix (0 through 41) may be set on the counter manually and inserted into the INS computer by depressing either the DEST FIX or the STORE pushbutton.

NOTE

Positions 42 through 49 can be displayed, but are inoperative.

The DEST FIX pushbutton illuminates when the destination number on the panel and the destination approached by the aircraft are not the same. When they are again the same (thumbwheels must be rotated), the light will go out. In all modes the light will come on when pilot action is required. When the DEST/FIX switch is placed in either STORED or VARIABLE FIX, the light will come on. When the STORE pushbutton is depressed the light will go out. In any mode in which a new destination is selected by depressing the STORE pushbutton, the light will go out when the system accepts the new destination selection. When a destination inside the aircraft's minimum turn radius is selected in the STORED MAN or VARIABLE DEST mode, the DEST FIX light will blink on and off. When the aircraft's location falls outside the minimum radius path, the blinking DEST FIX light will extinguish and the destination will be accepted. In the STORED MAN mode, the light will also come on if a destination is passed over by 15 miles without selecting a new destination. (DTG 15 NM or greater and increasing).

DISTANCE-TO-GO AND GROUNDSPEED INDICATOR

A distance-to-go and groundspeed indicator is installed on the instrument panel. Digital indicators display the distance between the aircraft position and the destination, and the groundspeed, in units of 1 nautical mile and knots, respectively. When a new destination is selected either automatically or manually the indicator will change to show the new distance-to-go. The distance-to-go indication will decrease toward zero while approaching the destination, then increase after passing the destination if flight is continued on the same course. Distance-to-go will not read zero at destination if the computed cross-course distance is greater than 1/2 nautical mile, since readout resolution is to the nearest nautical mile.

BEARING, DISTANCE, HEADING INDICATOR (BDHI)

The INS computes true heading and steering information and this information can be displayed by the BDHI installed on the instrument panel. The rotating compass card of

INS STEERING CHARACTERISTICS

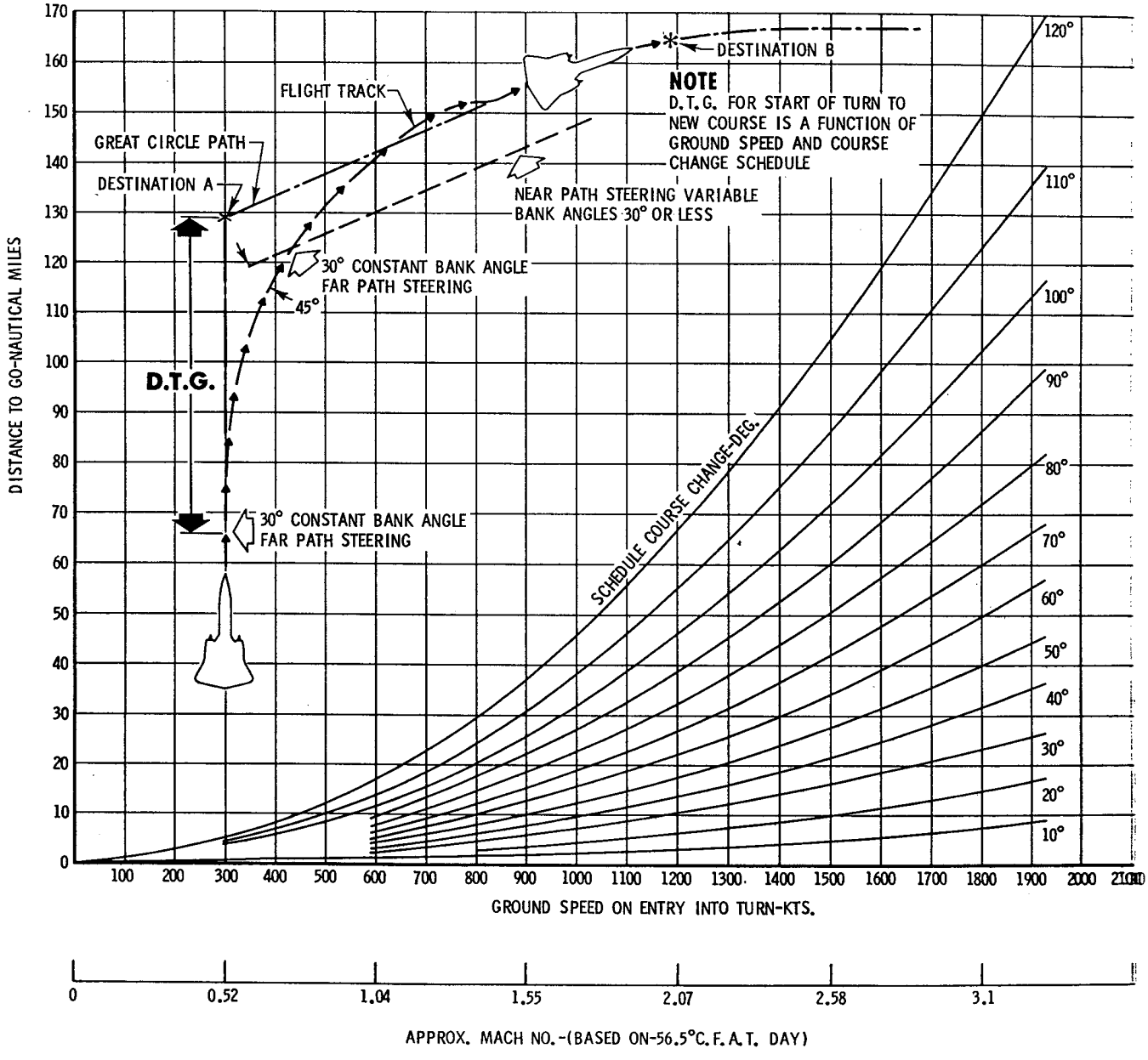


Figure 4-11

the BDHI receives the true heading signals as long as the MODE switch on the INS NAVIGATION control panel is in the NAV position. When the MODE switch is in the FRS position the compass card is driven by the FRS signals, although the INS system still generates true heading. Pointer 1 of the BDHI is driven by the ADF or TACAN as selected by the No. 1 needle selector switch. Pointer 2 is driven by the steering signal of the INS when the MODE switch on the NAVIGATION control panel is in the NAV or FRS position. Pointer 2 points to the direction of the great circle course or in ADF steering mode will point to destinations which are within 45 degrees of the aircraft heading (or indicate direction to turn if angular difference is greater than 45 degrees).

NOTE

- The aircraft will automatically fly the course computed by the INS and selected by the pilot only if the autopilot is in the AUTO NAV mode.

- A 45-degree turn indication on the BDHI pointer 2 commands a 30 degree bank angle to be made by the autopilot. The bank angle command is proportionately smaller when smaller turn angles are indicated on the BDHI.

COURSE SELECTION

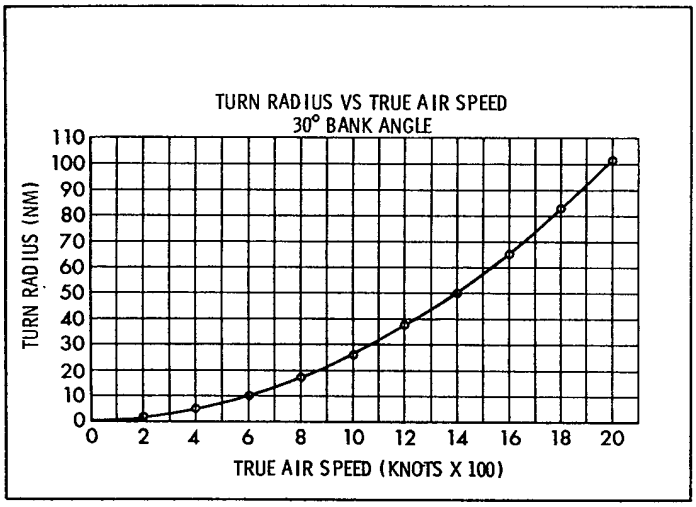
In the STORED AUTO mode, the INS is capable of providing steering information to any selected destination when the path from source to destination is greater than 30 nautical miles but less than 21,500 nautical miles (from 1/2 degree to 179 degrees of great circle arc). In the STORED MAN mode, the above restrictions exist only for destinations numbered 00 through 26. The sequence in which courses are provided depends upon the position of the DEST/FIX switch on the navigation control panel. In STORED AUTO position, course directions will be provided to stored destinations automatically in their numerical sequence; however, an out of sequence deviation can be made in STORED AUTO by selecting the desired out of sequence destination number on the destination select panel and depressing either the DEST FIX or STORE pushbutton. After the out of sequence deviation, other destinations will then continue to be automatically selected in numerical sequence. In the STORED MAN or VARIABLE DEST positions, steering directions to individual destinations are supplied after each destination is selected by depressing either the DEST FIX or STORE pushbutton. For STORED AUTO or STORED MAN modes, the steering information provided by the computer is a great circle flight path only if the destination selected is one of the first 27 sets of stored coordinates (00 through 26). ADF type steering will be commanded for STORED destination selections numbered 27 or greater and for all VARIABLE DEST mode selections. In STORED MAN mode, the computed course starting point is determined as follows:

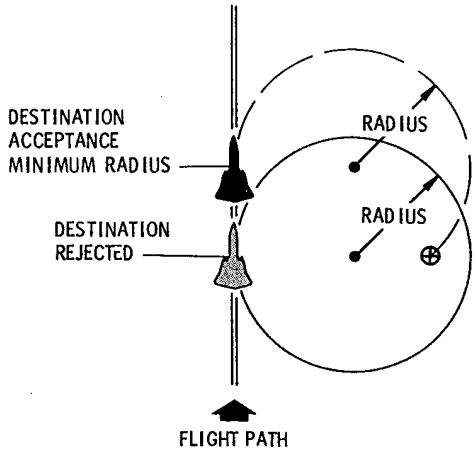
a. The position of the current destination is selected by the computer as the starting point for the new course if the aircraft computed position is within 100 miles of this point when the STORE button is depressed.

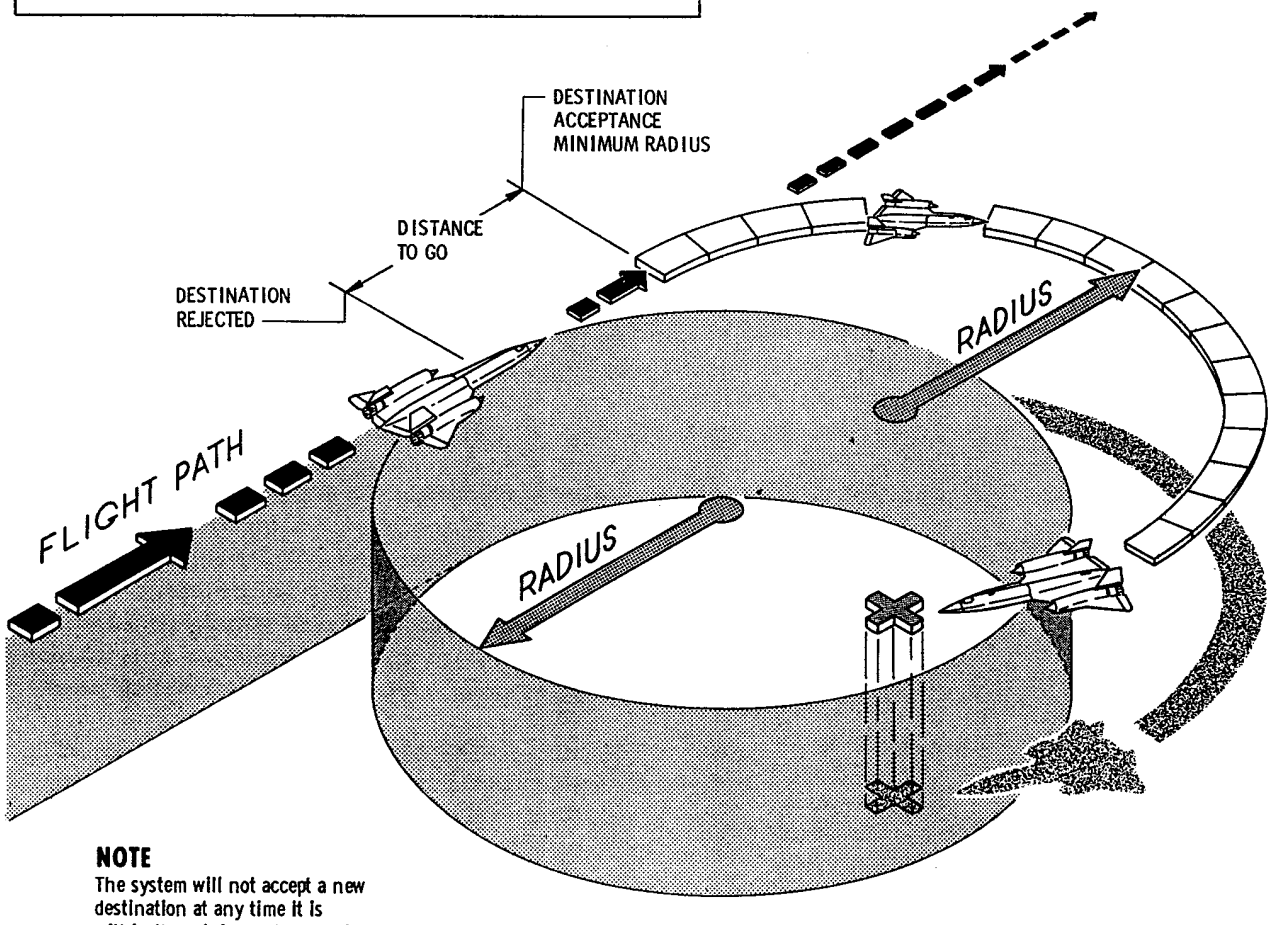
b. The computed position of the aircraft is selected by the computer as the starting point for the new course if the distance to go is more than 100 miles from the current destination.

After a course has been selected and calculated and either great circle or ADF type steering provided to navigate toward the course destination point, the INS will continue to navigate to that point regard-

INS DESTINATION REJECT PATTERN







NOTE

The system will not accept a new destination at any time it is within the minimum turn radius circles which move along with the aircraft. The radius is a functional of aircraft velocity for a 30° bank angle. $R \simeq 2.6 \times 10^{-5} V^2$ Where R is the turn radius in nautical miles and V is velocity in knots.

10-25-66
F200-77(c)

Figure 4-12

less of any change of position of the DEST/FIX switch until a new destination is selected by either automatic sequencing in the STORED AUTO position or by depressing the STORE pushbutton in the STORED MAN or VARIABLE DEST positions. If a destination selection is made in which the new destination is aft of the present course direction by an angle greater than 135°, the initial steering direction is indeterminant and the aircraft may roll out either right or left in turning around to the new course.

Fixed-Path Flight Plan

A preselected-path flight plan will be flown in AUTO mode. Consecutive destinations 00 through 41 will be selected automatically. The point-to-point paths will be segments of great-circle arcs for destinations 01 through 26, and direct for destinations 27 through 41. The use of STORED AUTO mode results in smooth entry turns at required bank angle up to a maximum of 30 degrees to the next course. Turns will be initiated before reaching the destination and the turn point will depend on aircraft groundspeed and the degree of course change required.

Deviation from Fixed-Path Flight Plan Using Stored Destinations

Stored destinations may be selected manually in any arbitrary sequence, and a destination can be selected any number of times during a mission. Any partial sequence of the stored destination fixed-path plan can be used by manually selecting the first destination of the sequence, then switching to STORED AUTO mode until the desired sequence is accomplished. Then, manual selection of a new stored destination causes a new course to be computed as described above.

NOTE

In the STORED MANUAL mode, if the aircraft flys over the destination in great circle steering without selecting a new destination, the DEST/FIX light comes on and the vehicle will alternate between right and left steering signals. The DEST/FIX light operates similarly in ADF steering; however, the aircraft will fly in circles, always coming back over the selected destination.

Deviation from Fixed-Path Flight Plan Using Stored Auto

One or more destinations can be skipped by selecting the destinations desired on the digital counters of the DESTINATION SELECT PANEL and depressing the STORE pushbutton with the DEST/FIX switch in the STORED AUTO position. The INS will complete the track in progress when the STORE pushbutton is depressed but the next automatic sequence will select the course to the desired destination.

In the STORED AUTO mode, the destination select light is extinguished when the number on the destination select panel agrees with the stored destination which is presently selected. The stored destination which extinguishes the light will be the same as the stored destination toward which the aircraft is flying except when selecting a destination out of sequence in the STORED AUTO mode.

Example: The aircraft is flying towards destination 02 in the STORED AUTO mode and 02 is selected on the destination select panel. The destination select light is extinguished. The pilot decides to skip destination 03 and fly from destination 02 to 04. He selects 04 on the panel and depresses

the store button. The light will now be extinguished only on destination 04 even though he is still flying towards 02. This indicates to the pilot that 04 has been accepted as the next destination.

Use of the VARIABLE INPUT Indicator For Unstored Destinations

Use of destination coordinates set on the VARIABLE INPUT indicator and N-S selector requires that the DEST/FIX switch be set to the VARIABLE DEST position. ADF-type steering to the point selected is provided when the STORE pushbutton is depressed. The initial ADF-type steering heading is based on computed present position. Coordinates of stored destinations can be duplicated.

LIMITATIONS OF DESTINATION SELECTION

Maximum Path Length

The maximum great-circle arc between source and destination is 179 degrees to permit definition of direction. This constitutes a distance of approximately 17,800 nautical miles from source to destination.

Minimum Path Length

In the STORED AUTO mode, a course cannot be selected when the distance from the start point (either a stored destination or the aircraft's present position) to the next destination is less than 30 nautical miles. The computer will ignore any attempt to select such a destination. In the STORED MAN mode the 30 mile restriction exists only for destinations numbered 00 through 26. However, all destination selections are restricted by comparing the desired destination's relative location with the aircraft's minimum turn radius capability. (The minimum turn radius is computed as a function of ground speed.) The destination is accepted if it is outside the minimum turn radius path. If the desired destination is inside the minimum turn radius path, the DEST FIX light on the DESTINATION SELECT PANEL will blink on and off, indicating that the computer has acknowledged the destination. The aircraft will continue on its same course until its location falls outside the minimum turn radius path. At such time, the DEST FIX light will extinguish and the destination will be accepted. (See figure 4-12.)

Minimum Distance Between Destinations

In the STORED AUTO mode, a course cannot be selected when the distance from the start point (either a stored destination or the aircraft's present position) to the next destination is less than 30 nautical miles. In the STORED MAN mode the 30 mile restriction exists only for destinations numbered 00 through 26.

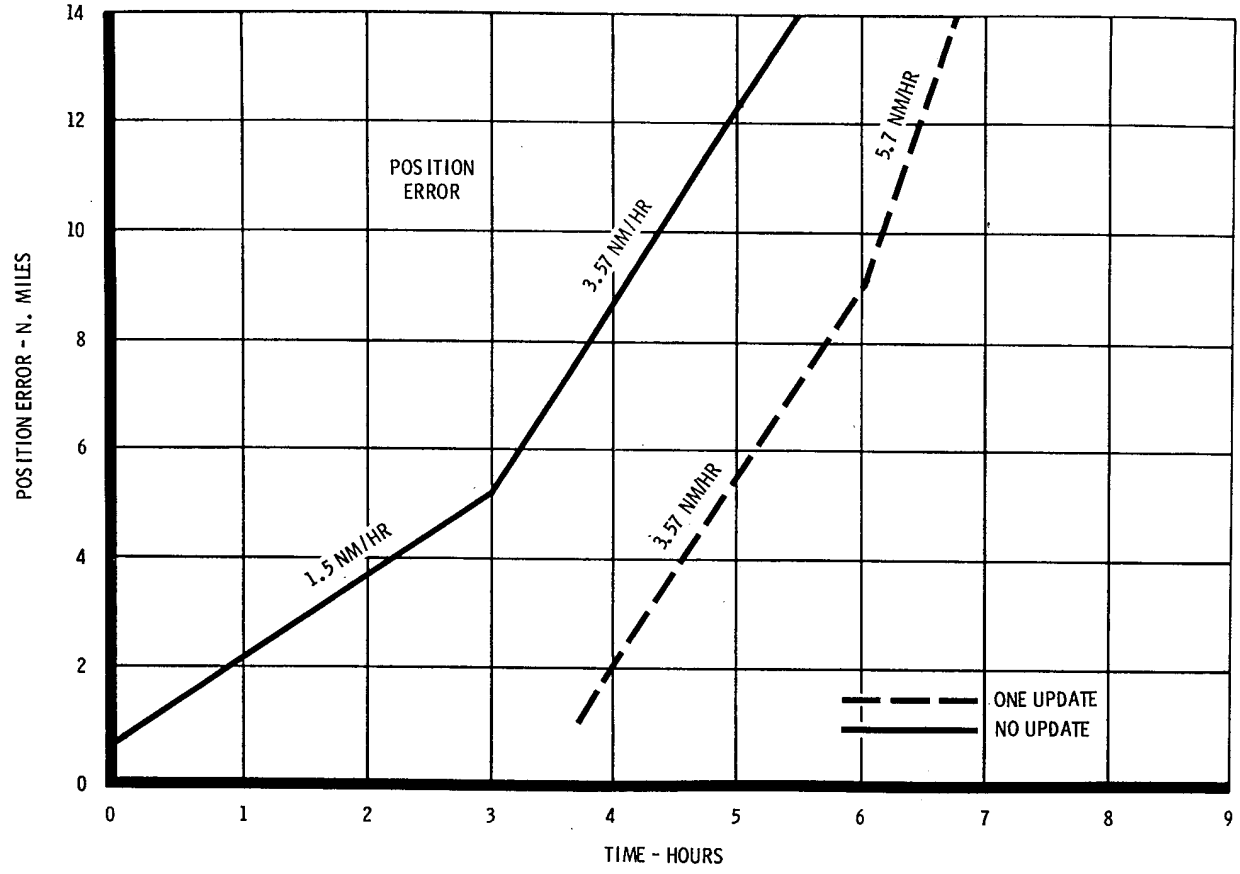
FIX TAKING

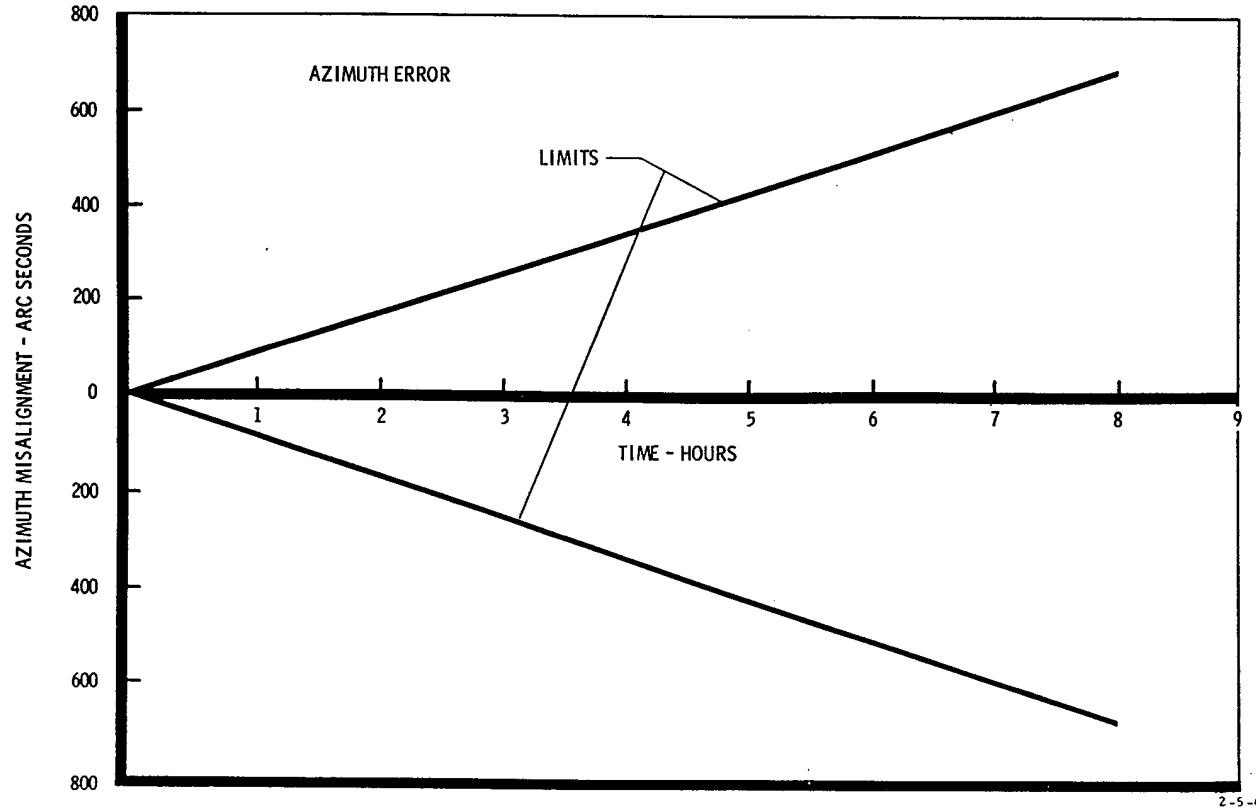
Since all rotating gyros are subject to some drift, alignment of the coordinate reference frame established by the gyro platform tends to depart from the true coordinate frame after a period of time. This introduces errors in position and azimuth which increase with time. (See figure 4-13.) The indicated position can be updated by taking visual fixes when the coordinates are known. These fixes are taken by use of the periscope and are inserted into the INS as follows:

1. Either select the desired prestored destination on the destination select panel or set the coordinates of the fix point in the VARIABLE INPUT indicator and N-S selector.

2. Turn the DEST/FIX switch to the appropriate STORED or VARIABLE FIX position. (Use STORED FIX position if the fix to be made is at a prestored coordinate point.)

INS POSITION AND AZIMUTH ERROR





2-5-66
F200-49(b)

Figure 4-13

3. Pull the MIRROR SELECT handle to the aft position for surface viewing and select the narrow view magnification with the PERISCOPE control. When the fix point is identified visually, position the periscope cursor with the FIX ADJ knob so that it will intersect and track the fix point. Continue tracking until the fix point crosses the periscope horizontal reference line.

4. Depress the STORE pushbutton at the instant the fix point crosses the intersection of cursor and horizontal reference lines. (At high speeds, a 2-second delay in depressing the STORE pushbutton will result in a position fix error of approximately 1 nautical mile.) The computer will make the fix correction as follows:

   a. Correcting the inserted fix position to represent the position of a point immediately below the aircraft at the instant of STORE pushbutton depression.

   b. Comparing the fix position with the inertially computed position at the instant of STORE pushbutton depression, and displaying the updated position on the PRESENT POSITION indication.

   c. If the difference is greater than 15 nautical miles, the computer program will not make the fix. Indication that a fix was not made is indicated by illumination of the INS FIX REJECT light on the annunciator panel.

   d. The difference will be displayed, up to a maximum value of 59 NM, on the latitude minutes counter of the DESTINATION/FIX POSITION Indicator (section of the counter inside the white outline block). The fix difference will be displayed whether the fix updates or is rejected. The display will remain until either another fix is taken or another destination is selected.

NOTE

The fix correction only updates the coordinates displayed in the PRESENT POSITION windows and does not realign the platform. The rate of error buildup accrues from the time the INS system was switched to the NAV mode.

A stored destination may be used as a fix by selecting the destination number on the destination select panel, moving the DEST/FIX switch to STORED FIX position, and depressing the STORE pushbutton.

Fix Sequence

No position fix should be taken before at least 2 hours have elapsed (including ground operating time) in the NAV mode of operation. A fix should be taken as soon thereafter as practicable. The optimum time to take the first fix is between 2 and 2-1/2 hours after selecting NAV operating mode. Subsequent fixes should be taken at intervals not exceeding 1-1/2 hours.

Fix Limit

For all fixes except those taken on stored positions 38 and 39, the maximum position fix corrections that will be accepted are 15 nautical miles of latitude correction and/or 15 nautical miles of longitude correction. An attempt to make a position fix that exceeds these values will cause the master caution light and the INS FIX REJECT light on the annunciator panel to illuminate. The INS FIX REJECT light will remain on until a subsequent acceptable fix is taken, or until the DEST/FIX switch is moved to a non-

fix position. Inability to obtain an acceptable fix correction can be due to incorrectly stored fix point coordinates, incorrect fix point identification, or degraded INS accuracy. More than one attempt to achieve fix corrections should be made before concluding that the INS is not reliable. STORED FIXES 38 and 39 do not use the 15 nautical mile update limit for fix reject, but use a variable limit which is loaded to the desired value during preflight preparation. This variable limit capability can be used for INS performance prediction prior to a specific mission. For example, if it is known that INS had to be accurate within a certain limit to accomplish a specific mission, a STORED FIX on either 38 or 39 just previous to entering the mission area would give a criteria for mission abort. Position 38 or 39 fixes are the same as normal stored fixes except for the variable fix rejection criteria.

INS ACCURACY

Maximum position error will accrue at an average rate of 1-1/2 nautical miles per hour during the first 3 hours, and at an average rate of 3.6 nautical miles per hour thereafter.

INS Reliability Check

STORED FIXES 40 and 41 are designed to check INS performance before takeoff to attempt to predict INS accuracy during the flight. The aircraft is accurately positioned over a known spot and a STORED FIX is take as follows:

1. Stop aircraft at designated runway position.
2. Destination select switch - Pos. 40.
3. DEST FIX switch - STORED FIX.
4. STORE or DEST FIX pushbutton - Press.
5. INS FIX REJECT light - OFF.

This procedure updates the INS to a point 0.1 nautical mile or less from the starting point coordinates.

Acceptance of the position 40 fix indicates that the INS error is 0.4 nautical miles or less in error in either latitude or longitude and that computed north and east velocities are each less than 3 feet per second. These INS performance criteria are based on an anticipated time duration of 20 minutes from NAV entry until the position 40 or 41 fix.

If INS FIX REJECT light comes on - INS accuracy may be marginal.

6. DEST FIX switch - STORED MANUAL.
7. Destination select switch - As briefed.
8. STORE or DEST FIX pushbutton - Press.
9. INS FIX REJECT light - Off.
10. DEST FIX switch - STORED AUTO.

Effects of No. 3 Inverter Failure on INS

The No. 3 inverter supplies power to the INS. Consequently, a No. 3 inverter failure may have catastrophic results on the INS. The system performance may be degraded after switching to the emergency inverter. The degradation of system performance will directly depend upon the elapsed time between the No. 3 inverter failure and switch over to the emergency inverter. If the No. 3 inverter fails and the INS outputs are no longer meaningful, the pilot should turn the INS MODE switch on the Nav Panel to OFF. This will lessen the possibility of damage to the system.

PERISCOPE

The periscope viewing system provides the pilot with a means for observing or making visual fixes on terrestial objects which cannot be seen directly from the cockpit. It can also function as a sky compass, and includes a display unit which projects maps and selected data on the presentation screen in the cockpit. Ther periscope windows, viewing optics, and projection equipment are located forward of the cockpit pressure bulkhead.

GROUND OBSERVATION

The basic downward looking function of the periscope system presents a minified image of a ground object, utilizing a fixed lens two-field system. The wide or narrow angle field of view is controlled by the PERISCOPE control. The modified wide-angle lens system provides a coverage of approximately 85° forward of nadir and is intended to be used for observations of large prominent ground objects. INS update fixing is possible when in the wide angle field of view. The modified narrow angle lens system provides a coverage of approximately 47° forward of nadir and is intended to be used for update fixing of the INS system by fixing on pre-selected ground objects. The forward look distance possible with either field of view is dependent upon the altitude and attitude of the aircraft at the time of the observation. Figure 4-15 gives the forward look range as a function of the aircraft attitude and altitude. The resolution of the optical system in all modes is better than that of the unaided eye. Due to the minification imposed by a fixed lens system, however, the pilot is only expected to identify prominent ground objects such as a coast line, lake or town. Also, due to the extreme slant viewing angle, there will be some apparent distortion when an object appears near the top of the reticle plate; especially when using the wide angle field of view. It is equipped with a tri-prism plastic grooved diffuser which provides for two eye viewing of the periscope image.

PROJECTOR DISPLAY

The periscope mirrors can be shifted so that a 35-mm strip film projector displays maps or other selected data on the presentation screen. The pilot may regulate the projector light intensity and advance or reverse the film as necessary in order to refer to the desired information. A film destruct capability is available and is actuated manually or automatically in case of ejection.

PRESENTATION SCREEN

A six inch presentation screen is installed at the top center of the cockpit instrument panel. The ground area displayed depends on the lens system selected; wide angle or narrow angle. When using the wide angle lens, the circle drawn near the center of the reticle plate indicates what will be visible with the narrow angle lens. The nadir point of the wide angle view is indicated by the intersection of the chord drawn across the lower half of the narrow angle view circle and the center vertical line on the reticle plate. The nadir point of the narrow angle view is indicated by the intersection of the horizontal line and center vertical line on the reticle plate. The nadir point, as indicated on the reticle plate, has been compensated to correct for the angle that the optical axis has been shifted forward due to the normal level flight attitude of the aircraft and the physical placement of the periscope system in the aircraft.

A compass rose is incorporated in the reticle plate; the numbers appear around the edge of the plate and are back lighted when the system is in the sun compass mode.

A pair of vertical dashed lines are provided to show the path of a ground object as it moves from top to bottom on the presentation screen. The dashed lines are tangent to the narrow angle circle and show the pilot what will be visible in the narrow angle view as soon as the object appears in the wide angle view.

PERISCOPE

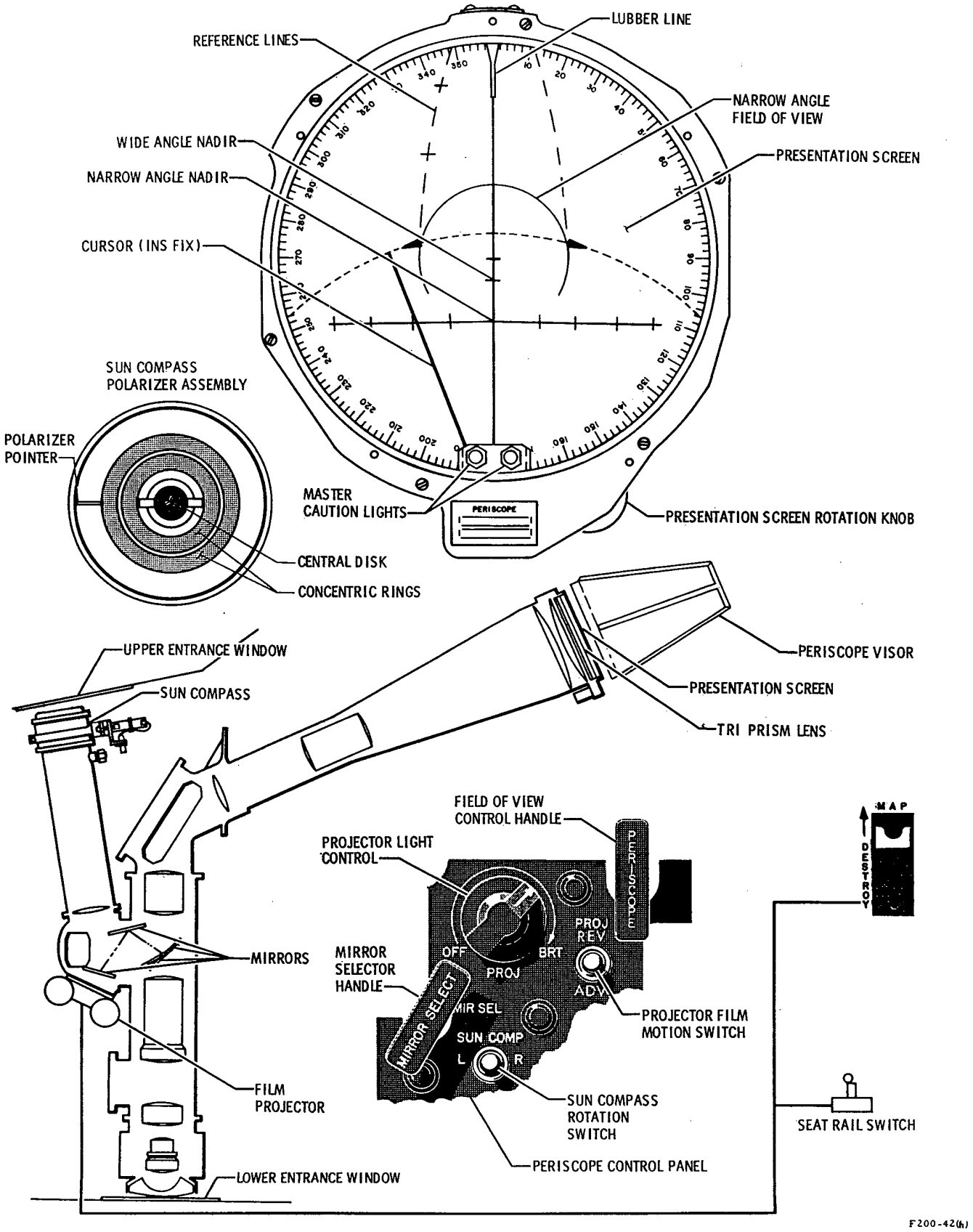


Figure 4-14

A movable cursor, remotely controlled from the INS navigation control panel, is used with the narrow angle "nadir" line to correct the INS for position error. The reticle plate or cursor is not illuminated. A serrated thumb knob in the lower right side of the presentation screen is used to rotate the reticle plate.

Periscope Lens Control Handle

A handle, labeled PERISCOPE and located on the lower left side of the cockpit instrument panel, is used to select the desired lens system wide or narrow angle view. The wide angle lens is selected by pulling the handle to the out (aft) position. The narrow angle lens is selected by placing the periscope handle in the in (forward) position.

Mirror Selector Handle

A T-handle, labeled MIRROR SELECT, controls the mirrors within the basic periscope system. The handle can be positioned to one of three positions as follows:

a. In (forward) position selects film projection.

b. Mid detented position selects the sun compass for overhead viewing. (Approximately 1/3 distance to OUT).

c. Out (aft) position selects the surface viewing periscope.

Projector Light Switch

A rheostat switch, labeled PROJ, controls the film projector light intensity. The projector light is switched OFF at the full counterclockwise position. The projector light is turned on by rotating the rheostat toward the BRT position. Intensity of the image on the presentation screen is increased by further clockwise rotation. Power for the light is furnished by the essential dc bus.

Projector Film Switch

A momentary three-position toggle switch, labeled PROJ, controls movement of map and data film. When the switch is held in the down position the film will advance. When the switch is held in the up position, the film strip will rewind. The center position is OFF. Power for the switch is furnished by the essential dc bus.

SUN COMPASS

The sun or sky can be observed with the periscope by shifting the mirrors for upward viewing. A midpoint detent is provided in the mirror selector control for positioning the periscope optics in this position. A knurled thumb knob located at the lower right of the presentation screen is used to rotate the reticle plate, and a toggle switch labeled sun compass with L and R positions located on the periscope control panel controls an electric motor which rotates the polarized disk. The sun compass is used as a backup to other heading devices when in locations where other devices might not function accurately. It is used to make 180° turn-arounds or emergency heading determinations. It is also used to make periodic cross checks of other heading devices at any point along the flight path.

The sun compass utilizes the precomputed azimuth (Zn) of sun and the sun's image on the presentation screen. Accuracy is within 2° when the sun's elevation is $+6^{\circ}$ to 50°. At elevation values above 50°, the heading error becomes greater. It also utilizes the precomputed azimuth of sun and the sky polarization phenomenon. Accuracy is within 2° when the sun's elevation is -8° to $+20^{\circ}$.

PERISCOPE DATA

Representative capabilities of Periscope in Ground View Mode. Airplane Angle of Attack Nominal 7°.

ALTITUDE ABOVE TERRAIN	NARROW ANGLE FIELD OF VIEW			WIDE ANGLE FIELD OF VIEW		
(Feet)	Forward (NM)	Lateral (NM)	Time * (SEC)	Forward (NM)	Lateral (NM)	Time* (MIN)
20,000	3.7	1.5	-	53	6	-
30,000	5.6	2.6	-	80	10	-
40,000	7.3	3.5	-	107	14	-
50,000	9.4	4.3	-	134	18	-
60,000	11.3	5.2	-	161	21	-
70,000	13.2	6.1	26	188	25	6.2
80,000	15.1	7.2	30	215	29	7.1
90,000	17.	7.9	34	242	32	8.

* The approximate time required for an object to appear at the top of the reticle plate and move down to the nadir fix line. Mach 3.1 and an attitude of + 7° is assumed.

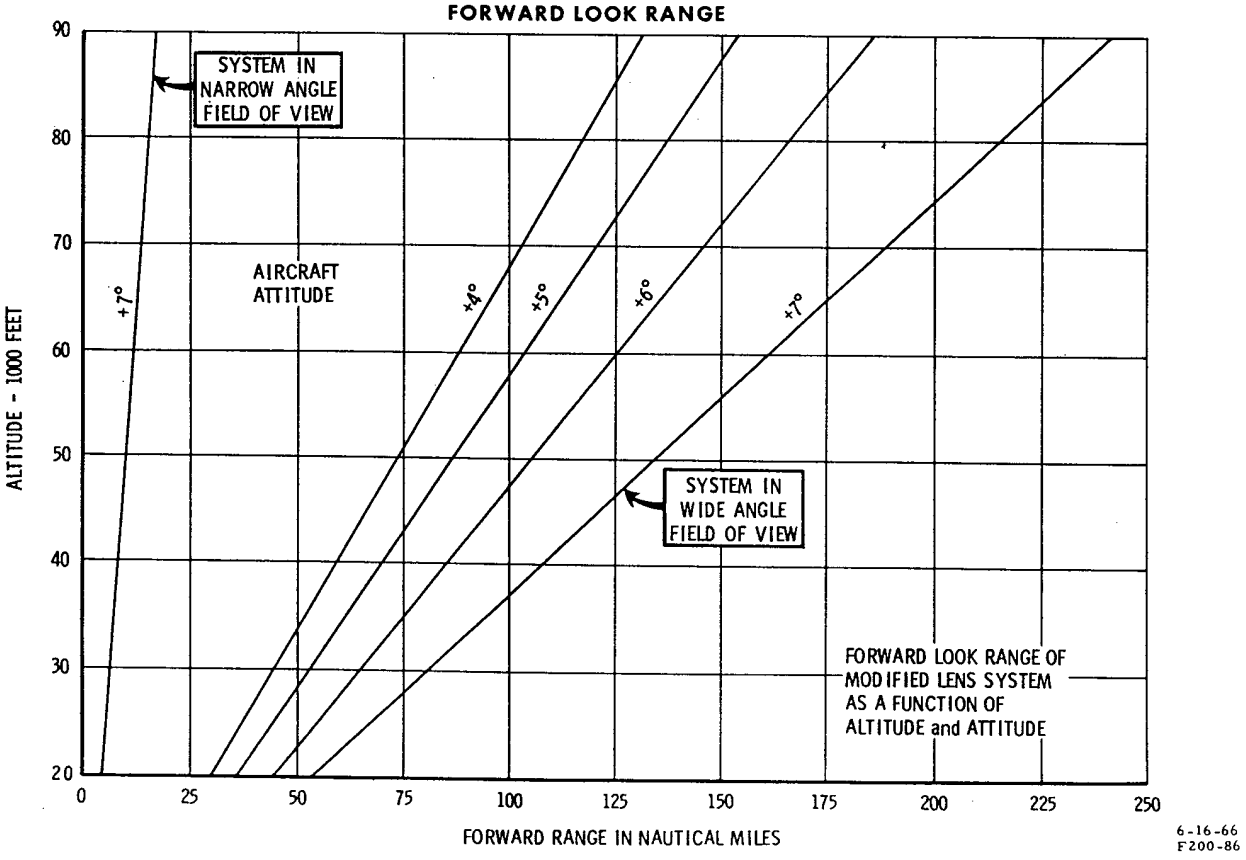


Figure 4-15

The following definitions are applicable to the sun compass procedures:

Polarizer pointer - The red pointer on the electrically driven polarizer disk. It takes the place of the sun when the sun is too low in the sky.

Lubber line - The fixed pointer at the top of the presentation screen.

Compass Rose - A set of numbers around the periphery of the manually rotated reticle plate.

Zn - Azimuth of Sun - True bearing of the sun relative to a particular position on the ground at a specific time.

RB - Relative Bearing of Aircraft - The horizontal angle between the true heading of the aircraft and the true bearing of the sun.

TH- True Heading of Aircraft - The heading of aircraft relative to the north pole.

Zn = TH + RB

Sun Image - Reflection of direct sun image as it appears at the edge of the reticle plate.

Polarized Sky Light - The characteristic of the atmosphere to polarize sun light by scattering. The maximum polarization appears at a direction 90° from the sun.

Sun Compass Switch

A three- position momentary toggle switch, labeled SUN COMP, on the periscope panel controls the rotation of the sun compass polarizer disk. The switch positions are labeled L and R. In the L position the polarizer disk will rotate in a counterclockwise direction. In the R position the polarizer disk will be rotated in a clockwise direction. Power is provided by the essential dc bus.

NORMAL OPERATION

DIRECT SUN (+6° to 50°)

A. True Heading Method

1. Determine the precomputed value for azimuth of sun (Zn).
2. Manually rotate compass rose until Zn value is over the sun's image.
3. Read True Heading (TH) of aircraft on compass rose, indicated by the lubber line.

B. Relative Bearing Method

1. Manually rotate compass rose so the lubber line indicates zero.
2. Determine the precomputed Relative Bearing (RB).
3. Read the Relative Bearing of aircraft on compass rose at point indicated by sun's image.

POLARIZED SKY LIGHT (-8° to 20°)

A. True Heading Method

1. Determine the precomputed azimuth of sun (Zn).
2. Electrically turn polarizer pointer toward the visible sunlight.
3. Adjust the central disk as dark as possible when the concentric rings are of equal brightness.
4. Manually rotate compass rose until Zn value is in line with the polarizer pointer.
5. Read the True Heading (TH) of aircraft on compass rose, as indicated by Lubber line.

B. Relative Bearing Method

1. Manually rotate compass rose so that lubber line indicates zero.

2. Determine the precomputed Relative Bearing (RB).

3. Electrically turn polarizer pointer toward the visible sunlight.

NOTE

If pointer is not positioned toward sun, 180° ambiguity will be encountered.

4. Adjust the central disk to be as dark as possible when the concentric rings are of equal brightness.

5. Read the Relative Bearing of aircraft on compass rose, as indicated by the polarized pointer.

DESTRUCT SYSTEM

A destruct system is incorporated in the airplane to destroy the projector film, and the maps. The film strip in the projector are destroyed by electrically igniting small thermite assemblies which burn at approximately 2000° for a minimum of 30 seconds. The water soluble maps are destroyed by forcing water from a small reservoir into the map case using nitrogen gas pressure from the canopy accumulator. The destruct system is actuated manually by a guarded switch labeled DESTROY located on the right forward panel. The system is activated when the switch is placed in the up position. A roller type micro switch on the seat ejection rails will automatically activate the destruct system if the pilot ejects. Power for the system is from the essential dc bus.

CAUTION

After landing nitrogen pressure will not be available to assist in raising the canopy if the destruct system has been actuated. The canopy may be jettisoned if pressure is depleted and help is not available.

OPERATING LIMITATIONS

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INTRODUCTION

This section provides general aircraft restrictions and engine operating limits that must be observed in normal operations. Some specific limits may be changed from time to time. Development flight tests are presently extending operational capabilities, making continued review of the limitations necessary. When necessary, to avoid delay in providing current limits to operating personnel, these specific limits will be supplied by the manufacturer's flight test organization at the operating site.

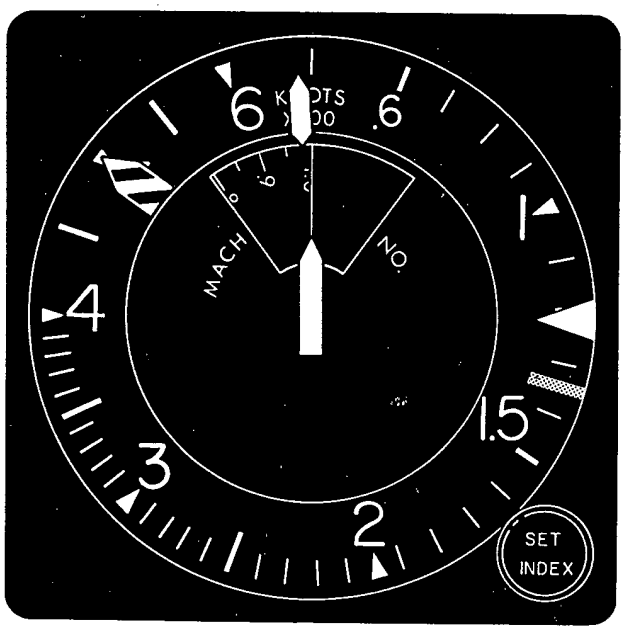
INSTRUMENT MARKINGS

The instrument markings shown in figure 5-1 are self evident and are not necessarily repeated elsewhere in this section.

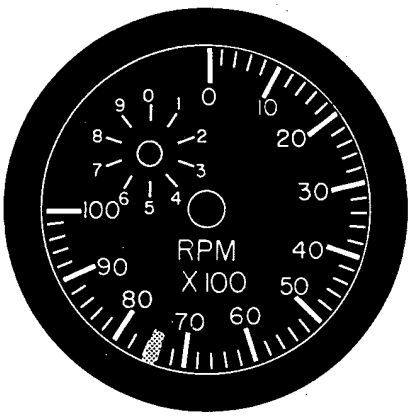
ENGINE OPERATING LIMITS

Pilot preflight briefing must include capability and limitations information pertinent to individual engines installed. General engine operating limits are summarized in figure 5-2. Thrust rating definitions are provided in Section I.

INSTRUMENT MARKINGS



AIRSPEED - MACH METER



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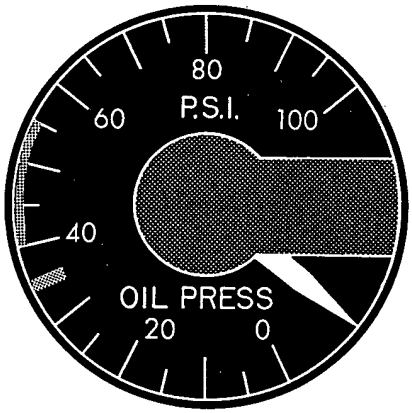
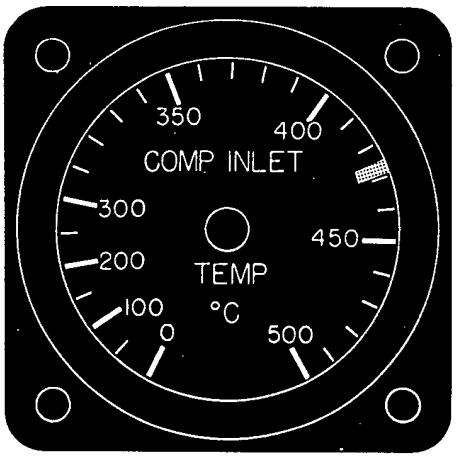


OIL PRESSURE GAGE



COMPRESSOR INLET TEMPERATURE GAGE

CODE

RED

GREEN

NOTE

LIMIT VALUE DENOTED BY EDGE OF RED LINE SO THAT INDICATION WITHIN MARKED RED RANGE EXCEEDS LIMIT VALUE

F200-43(1)(e)

Figure 5-1 (Sheet 1 of 2)

OPERATING LIMITATIONS

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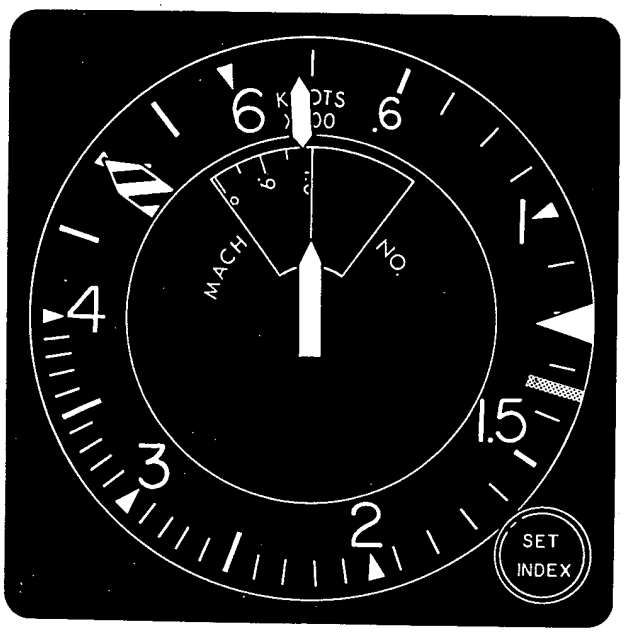
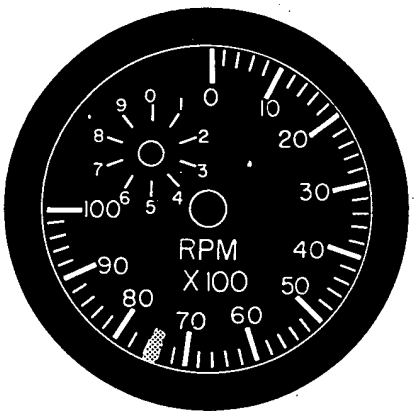


AIRSPEED - MACH METER



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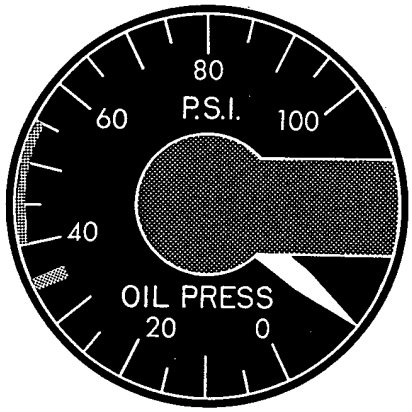

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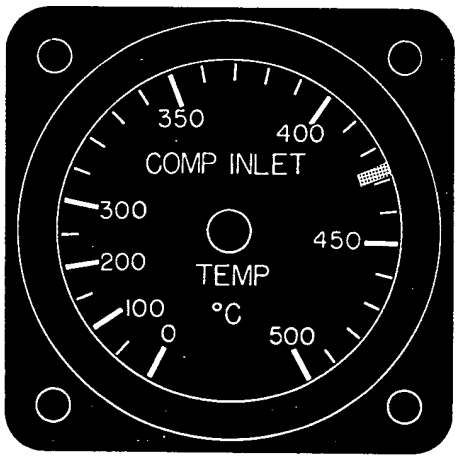


COMPRESSOR INLET TEMPERATURE GAGE

CODE

RED

GREEN

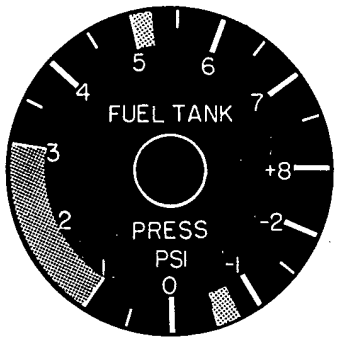
NOTE

LIMIT VALUE DENOTED BY EDGE OF RED LINE SO THAT INDICATION WITHIN MARKED RED RANGE EXCEEDS LIMIT VALUE

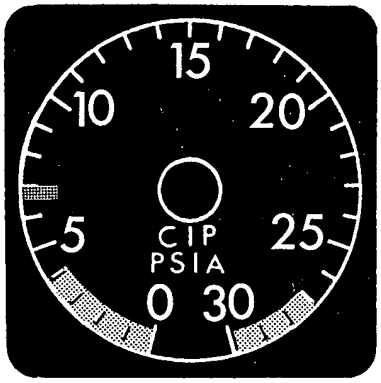
F200-43(1)(e)

Figure 5-1 (Sheet 1 of 2)

INSTRUMENT MARKINGS



FUEL TANK PRESSURE GAGE



COMPRESSOR INLET STATIC PRESSURE GAGE

CODE

YELLOW

RED

GREEN

NOTE

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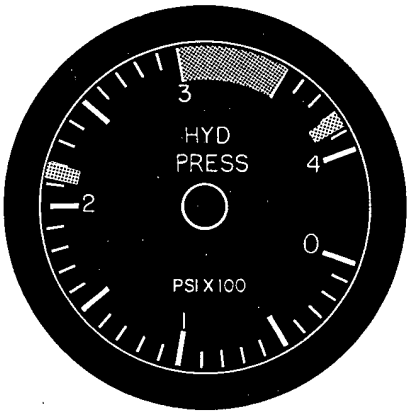
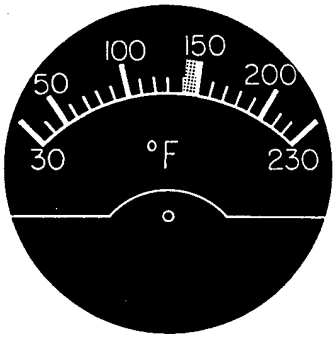
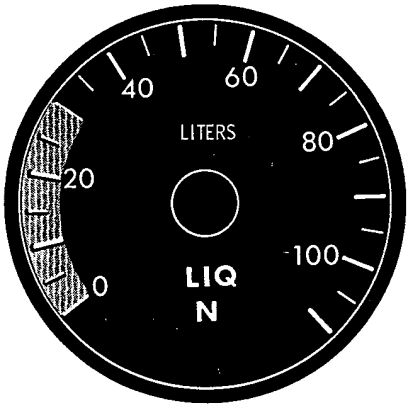


HYDRAULIC SYSTEM PRESSURE GAGES (A AND B - L AND R)



COCKPIT TEMPERATURE INDICATOR



LIQUID NITROGEN GAGE

4-20-66
F200-43(2)(d)

Figure 5-1 (Sheet 2 of 2)

ENGINE OPERATING LIMITS SUMMARY

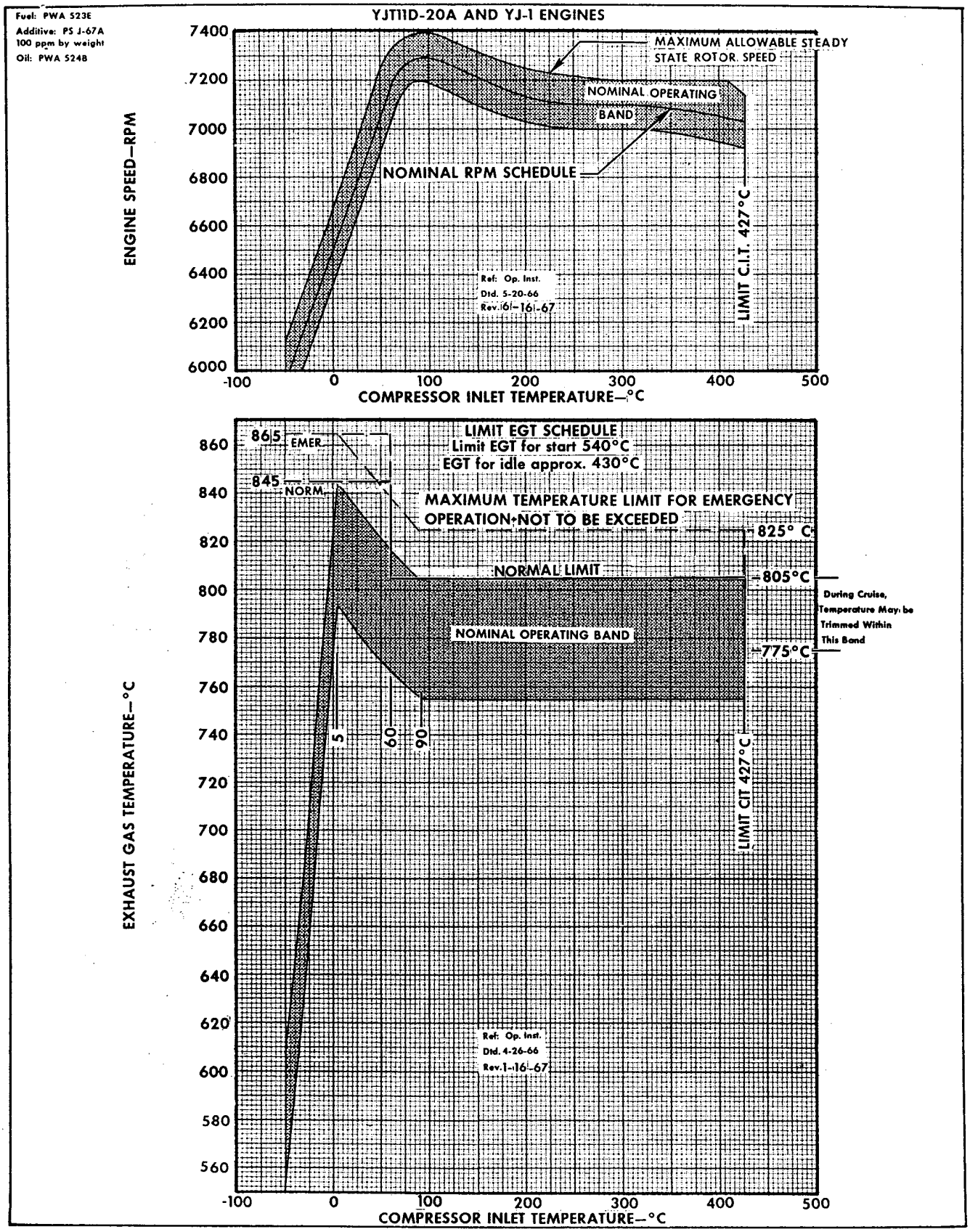
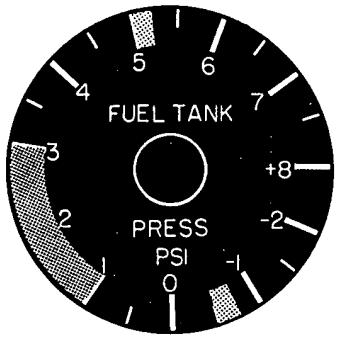
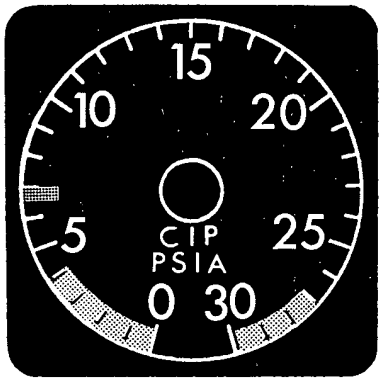


Figure 5-2

INSTRUMENT MARKINGS



FUEL TANK PRESSURE GAGE



COMPRESSOR INLET STATIC PRESSURE GAGE

CODE

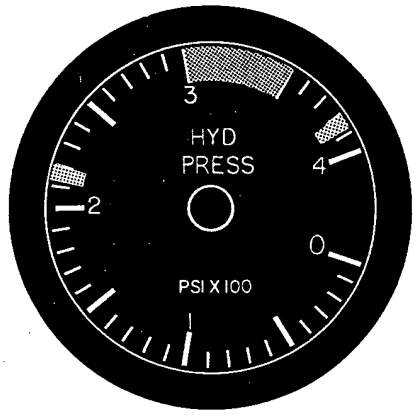
YELLOW

RED

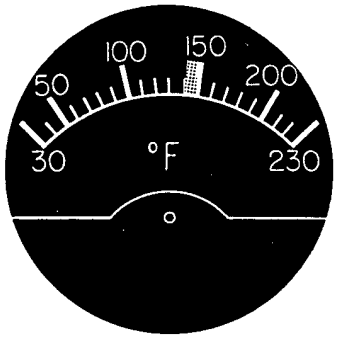
GREEN

NOTE

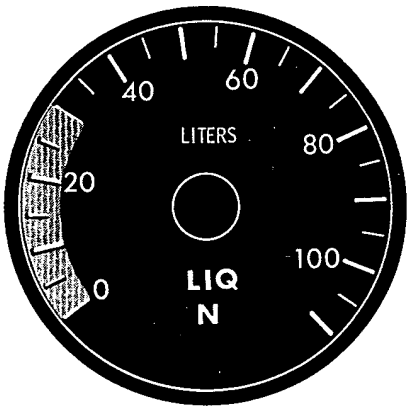
LIMIT VALUE DENOTED BY EDGE OF RED LINE SO THAT INDICATION WITHIN MARKED RED RANGE EXCEEDS LIMIT VALUE



HYDRAULIC SYSTEM PRESSURE GAGES
(A AND B - L AND R)



COCKPIT TEMPERATURE INDICATOR



LIQUID NITROGEN GAGE

4-20-66
F200-43(2)(d)

Figure 5-1 (Sheet 2 of 2)

ENGINE OPERATING LIMITS SUMMARY

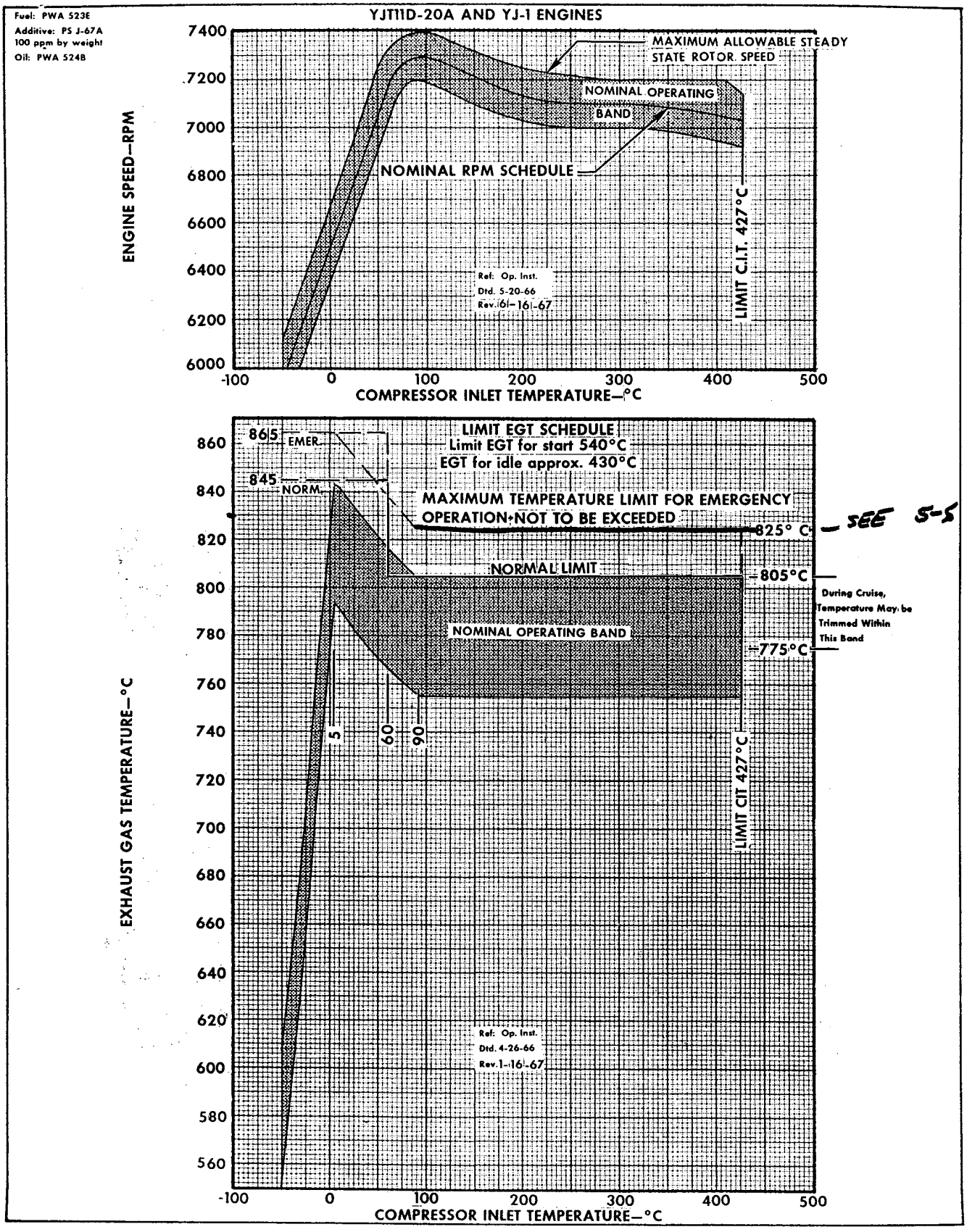


Figure 5-2

TIME LIMITS

YJT11D-20A and YJ-1 engines may be operated continuously at all ratings when within the normal exhaust gas temperature limits; however, no more than one hour may be accumulated with EGT in excess of the normal limit schedule, and EGT must be reduced immediately if an emergency limit temperature is exceeded. (See EGT Limits and figure 5-2.)

CAUTION

Continuous or accumulated operating time in the emergency EGT operating zone for more than 15 minutes may require engine removal.

EXHAUST GAS TEMPERATURE LIMITS

The nominal operating band, normal limits and emergency exhaust gas temperature operating schedules are prescribed as a function of compressor inlet temperature as shown in figure 5-2. Limit EGT's for continuous operation are 805°C when compressor inlet temperature is above 60°C, and 845°C when CIT is below 60°C. The setting at which the red warning light on the EGT gage illuminates and the fuel derichment system operates, if armed, is 860°C, a value which is above the normal operating temperature limit schedule.

Note

At compressor inlet temperatures below 5°C, the possibility of engine stall exists at EGT's between the maximum permissible value and the nominal operating band.

In the event that emergency engine operation is required, EGT may be increased to 825°C when above 60°C CIT, or to 865°C when below 60°C CIT; however, an accurate accounting of operating time in the emergency operating zone must be maintained.

Note

- Any operation in or above the emergency operating zone requires special maintenance action.
- The permissible emergency EGT level at low CIT's is above the derich system actuation point; therefore, the derich system must be disarmed if this level is to be attained.

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- The permissible emergency EGT level at low CIT's is above the derich system actuation point; therefore, the derich system must be disarmed if this level is to be attained.

COMPRESSOR INLET TEMPERATURE

The maximum allowable compressor inlet temperature is 427°C. In addition, deceleration must be monitored so that engine cooling rates will not be excessive. While above an airspeed of Mach 1.8, the aircraft maximum rate of descent should be such that rate of deceleration does not exceed 1.0 Mach in three minutes. There is no limitation on rate of deceleration while below Mach 1.8.

COMPRESSOR INLET PRESSURE

The minimum pressure recommended for airstarts from stabilized windmilling speeds is 7 psi. This pressure is marked by a green radial line.

ENGINE SPEED

Military and afterburning engine speeds are the same and are automatically scheduled by the fuel control as a function of Compressor Inlet Temperature. The normal schedule is shown by figure 5-2. Engine overspeed above 7450 rpm requires a visual inspection of the turbine. Notify the engine manufacturer if 7550 rpm is ever exceeded. Each instance of overspeeding should be reported as an engine discrepancy and should include the maximum rpm attained.

LIMIT FLIGHT SPEED AND ALTITUDE ENVELOPE

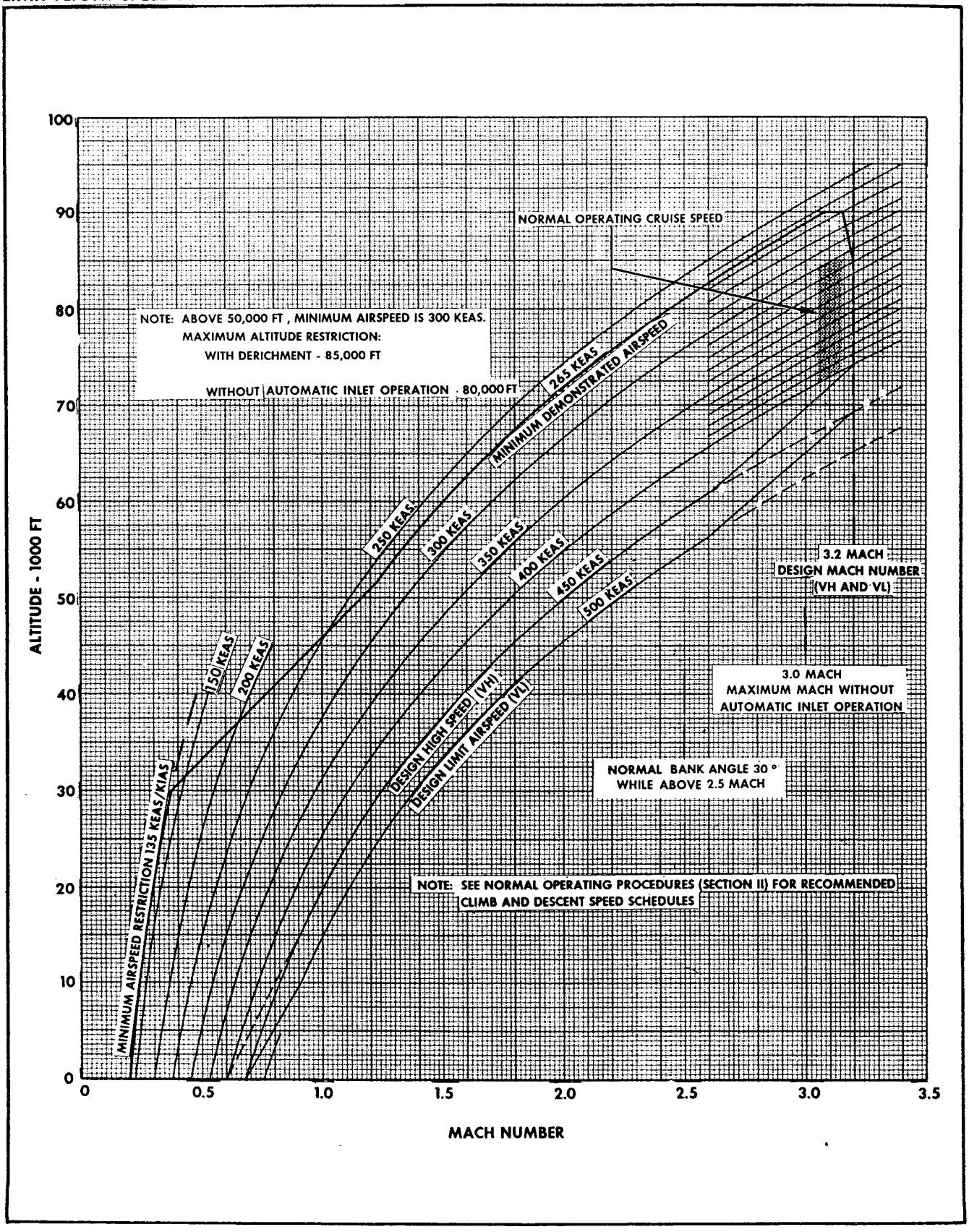

Figure 5-3

FUEL

The approved fuel is PWA 523E. The P&W approved source of lubricity additive, PSJ-67A, must be mixed with the fuel in the ratio of 0.29 gallons per 4000 gallons of fuel. Fuels such as JP-4, JP-5, and JP-6 may be used only for emergency requirements such as air refueling when standard fuel is not available and air refueling must be accomplished or risk loss of the aircraft. Operation with emergency fuels should be restricted to speeds below Mach 1.5.

OIL

The approved oil is PWA 524B. If necessary because of low ambient temperatures, it may be diluted with Trichloroethylene, Federal Specification O-T-634, Type 1, in accordance with Maintenance Manual procedures.

Oil Pressure

Oil pressures below 35 psi are unsafe and require that a landing be made as soon as possible, using minimum thrust required to sustain flight until a landing can be accomplished. Normal oil pressure is from 40 to 55 psi. Except at IDLE throttle settings, oil pressures between 35 psi and 40 psi are undesirable and should be reported after flight. A gradually increasing oil pressure up to 60 psi is acceptable at high Mach numbers provided the indication returns to normal values after aircraft decelerates to subsonic speed.

Oil Temperature

Oil temperature must be at least 60°F (15°C) prior to starting unless previously diluted with Trichloroethylene (PWA 9003). Engine oil temperatures above 290°C are unsafe and a landing should be made as soon as possible if the temperature cannot be maintained below this value. An engine should not be restarted after windmilling at subsonic speed when CIT is less than 15°C (60°F) for more than 5 minutes. If restarted, operation above IDLE with OIL TEMP warning light illuminated shall be as brief as possible.

MAXIMUM WEIGHT LIMITS

Maximum gross weight is not limited except by takeoff performance capabilities. Base maximum takeoff weights on information provided in Part II of the Appendix.

MAXIMUM ALTITUDE

Maximum altitude with derichment installed and operational is 85,000 feet; maximum altitude without derichment is 75,000 feet.

LIMIT AIRSPEEDS

(Refer to figure 5-3 for the limit flight speed and altitude envelope.)

MINIMUM AIRSPEED RESTRICTION

The stall warning light on the annunciator panel and the master caution light illuminate when angle of attack reaches 14° in flight. A tone is also produced in the pilot's headset. When above 135 KIAS, the speed at which stall warning occurs is the minimum airspeed restriction for the existing vehicle weight, c.g., and load factor unless operation is governed by a higher value of minimum KEAS as displayed by the Triple Display Indicator. Minimum airspeed is 300 KEAS above 50,000 feet.

INDICATED AIRSPEED

The Mach-airspeed indicator limit hand is set to indicate airspeed (KIAS) corresponding to 500 KEAS. However, the 500 KEAS limit applies only at altitudes above 9400 feet, and at airspeed below Mach 2.6. Below 9400 feet, limit airspeed decreases linearly with altitude from 500 KEAS at 9400 feet to 450 KEAS at sea level. Above Mach 2.6, limit airspeed decreases linearly from 500 KEAS at Mach 2.6 to 450 KEAS at Mach 3.2. See figure 5-4 for variation of KIAS with altitude for KEAS.

Note

Maximum recommended operating speeds are at least 50 KEAS less than limit airspeeds. 450 KEAS (Mach 0.9) is not recommended below 14,800 feet.

LIMIT AIRSPEED VS ALTITUDE

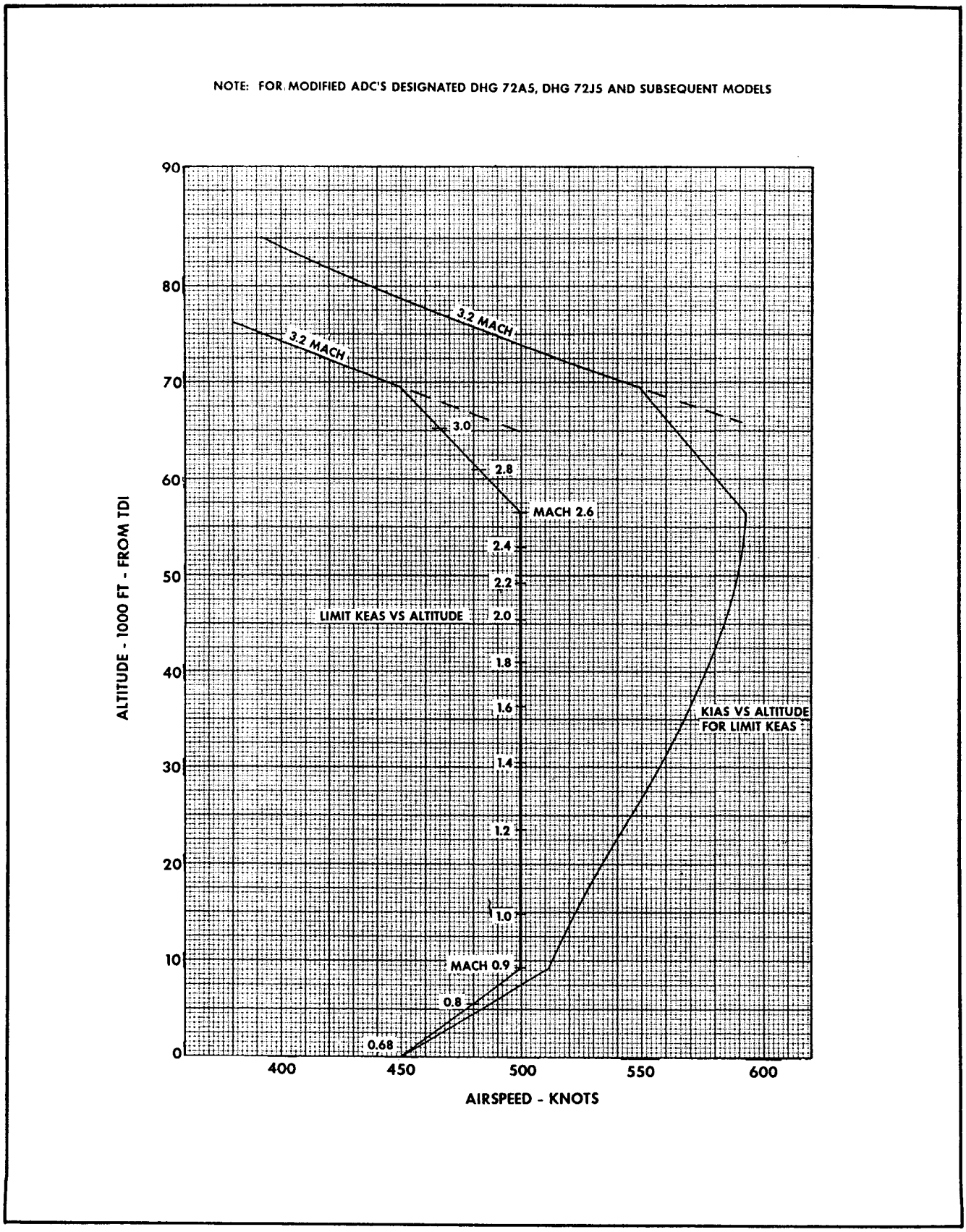

Figure 5-4

MINIMUM AIRSPEED LIMITS FOR 14° ANGLE OF ATTACK

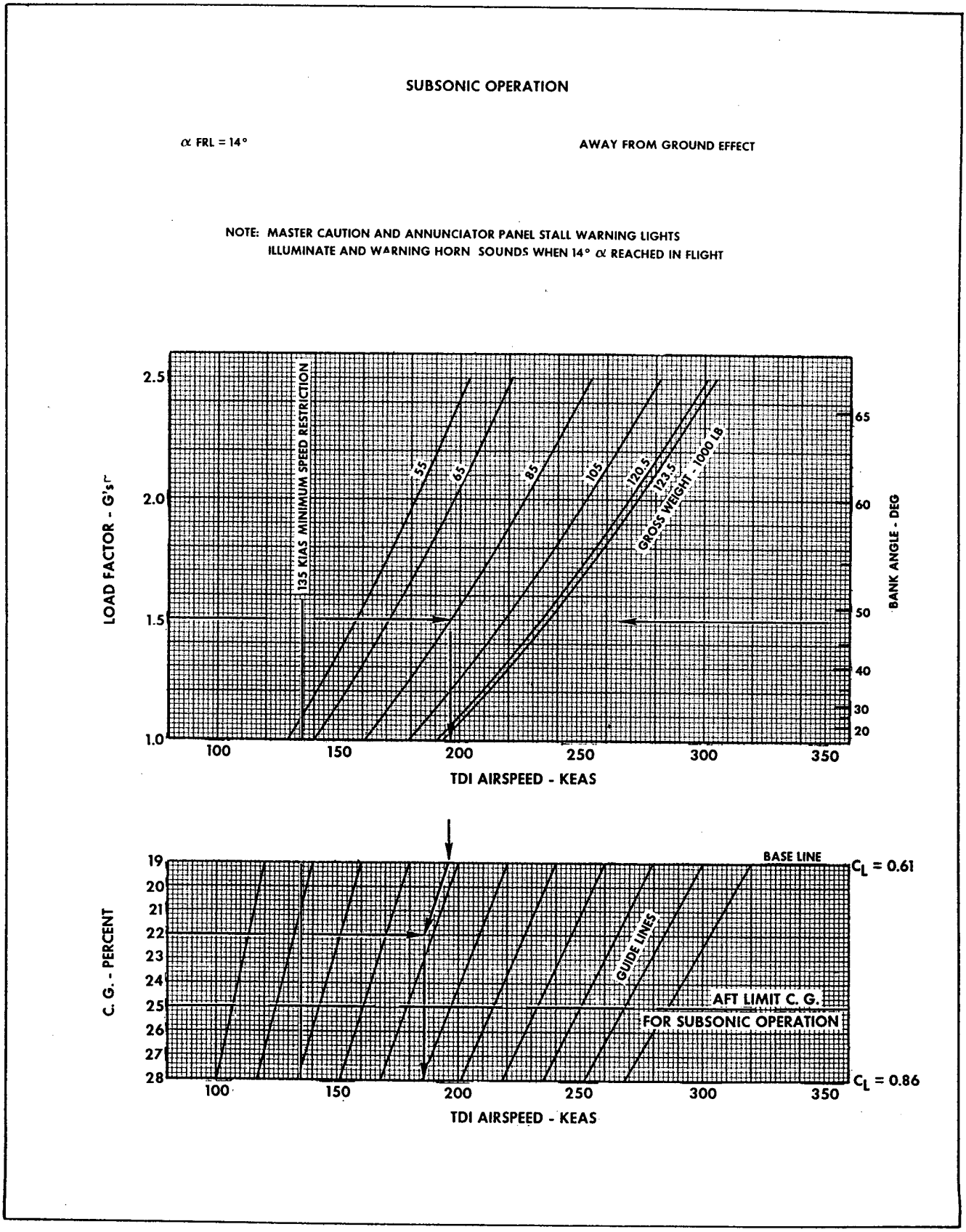

Figure 5-5

LIMIT LOAD FACTOR DIAGRAM

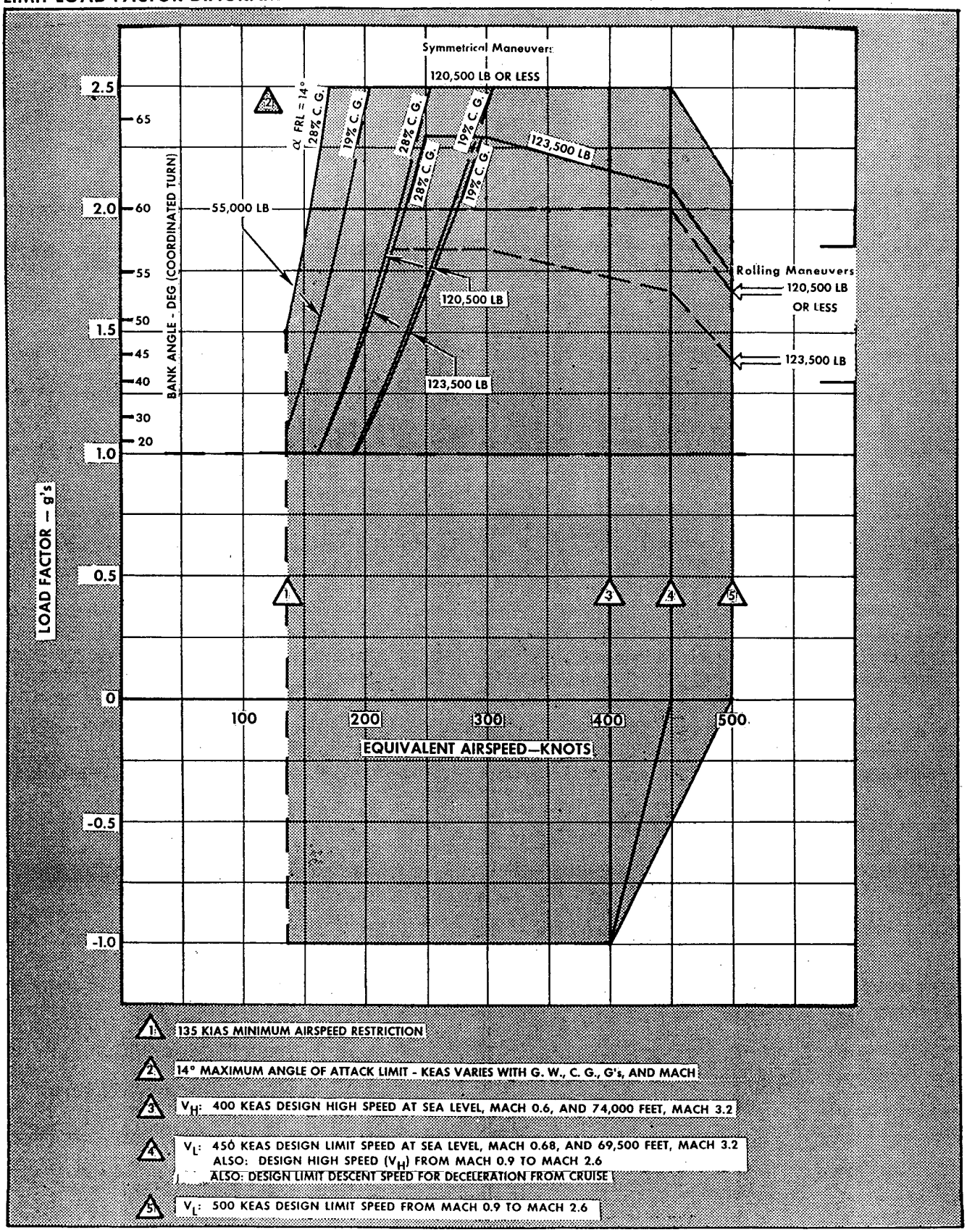

Figure 5-6

A red radial line at 135 KIAS represents the minimum subsonic speed restriction below 30,000 feet when the stall warning light is off.

EQUIVALENT AIRSPEED

The triple display indicator is not marked however, the limit equivalent speeds are as follows unless:

a. The Mach-airspeed instrument indicated airspeed equals either the limit airspeed hand indication or the minimum (135 KIAS) restriction.

b. The stall warning light illuminates or the stall warning tone is heard.

Maximum TDI Airspeed

The limit airspeed is 450 KEAS at sea level, increasing linearly with altitude to 500 KEAS at 9400 feet pressure altitude; then 500 KEAS between 9400 feet and the altitude for Mach 2.6. Limit airspeed then decreases linearly with Mach number to 450 KEAS at Mach 3.2. Normal operation cruise speed is 3.1 Mach.

Minimum TDI Airspeed

The minimum airspeed restriction varies linearly with Mach number from 135 KEAS (Mach 0.38) at 30,000 feet to 300 KEAS (Mach 1.34) at 50,000 feet, and is then a constant 300 KEAS to 85,000 feet (Mach 3.1).

LOAD FACTOR LIMITS

The maximum allowable positive load factor is 2.5 g's in symmetrical maneuvers and 2.0 g's in roll maneuvers as described by figure 5-6. The maximum negative load factor is -1.0 when below 400 KEAS varying from -1.0 to 0 g's at higher airspeed as shown by figure 5-6.

To avoid exceeding a safe angle of attack positive g's are limited to 1.5 g's when operating above 2.5 Mach. (This is equivalent to approximately a 45° bank level turn.)

PROHIBITED MANEUVERS

The aircraft shall be operated in a manner to avoid full stalls, spins, and inverted flight. Normal bank angle when operating above Mach 2.5 is 30 degrees.

RATE OF DESCENT LIMITATION

Rates of descent must be limited so as to maintain positive fuel tank pressure when sustained cruise speeds have exceeded Mach 2.8.

CENTER OF GRAVITY

The aircraft shall be operated within a c.g. range from 19% to 25% MAC while subsonic. The c.g. must be forward of 25% MAC for takeoff and should be as near to 19% MAC as possible with existing fuel for landing.

The aft c.g. limit is 28% MAC while supersonic. This limit results from stability considerations at high Mach number. Adequate stability exists at farther aft centers of gravity between Mach 1.2 and Mach 2.6 but for simplicity the aft limit is not changed. The purpose of elevon trim limits imposed in this Mach region is to alert the pilot of a major malfunction in the fuel system.

On those aircraft incorporating S/B 1141, if an aft c.g. emergency exists and EMER forward transfer is operated to place more than 4000 lbs in tank 1 and total fuel is less than 30,000 lbs, the aircraft should be limited to maneuvers causing not more than 1.5 g.

As elevon trim can be used as an indication of abnormal c.g. condition, the following pitch trim limits apply:

While subsonic - no more than 1° nose down.

RATED TIRE SPEED

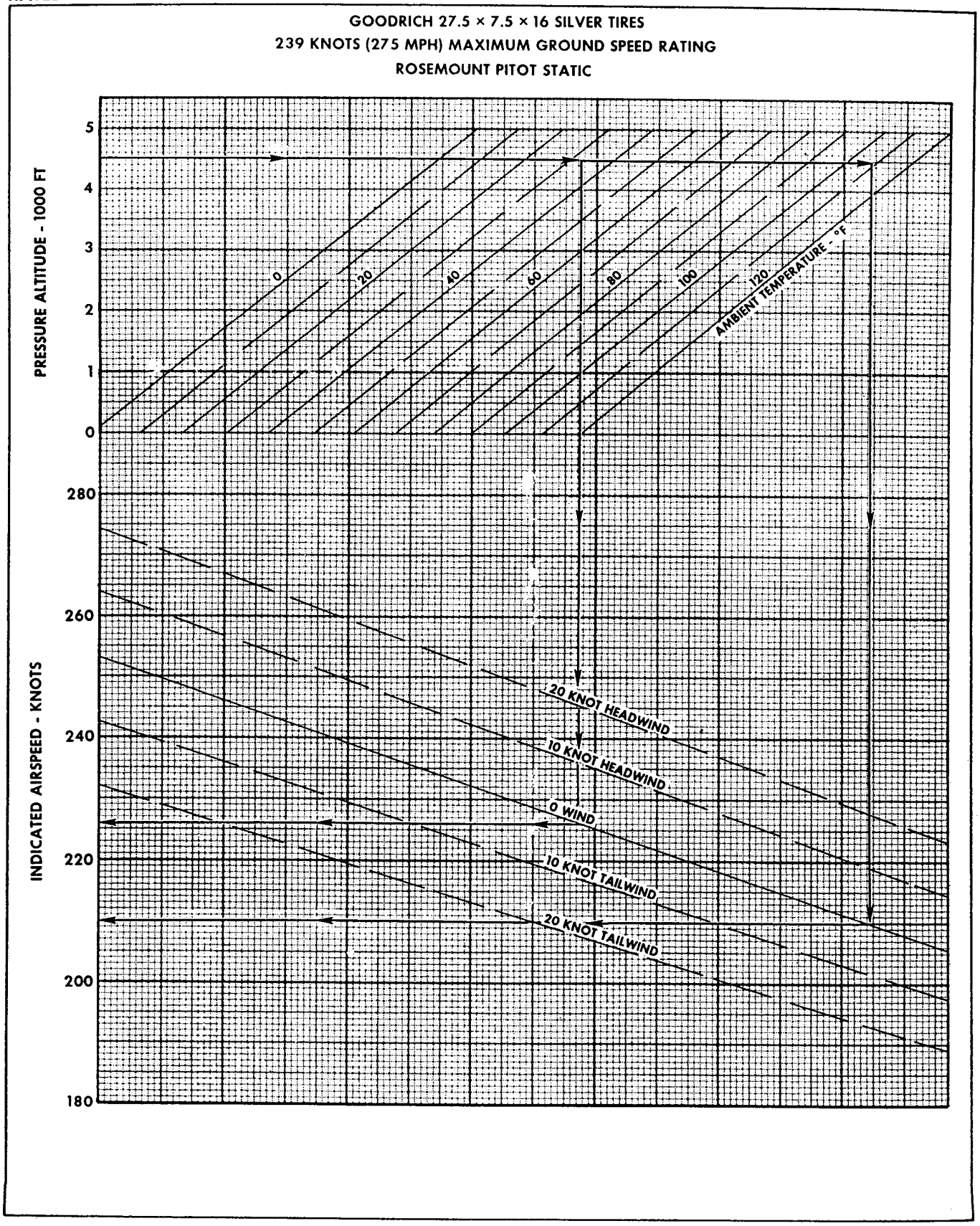

Figure 5-7

While climbing - 2-1/2° nose down from Mach 1.4 to Mach 2.6, 3-1/2° nose down above Mach 2.6.

At initial cruise the trim limit is 3-1/2° nose down at 28% c.g. As altitude increases and KEAS decreases, the 28% c.g. trim limit becomes approximately 2° more nose up per 50 KEAS decrease from 450 KEAS. (In addition, expect approximately 1° more nose up trim for each percent that c.g. is forward of 28% MAC).

FUEL LOADING LIMITATIONS

These limits to be supplied at the operating site.

AIRCRAFT SYSTEM LIMITATIONS

STABILITY AUGMENTATION SYSTEM

The SAS shall be on for all takeoffs and landings.

INLET SPIKE AND BYPASS CONTROLS

The spike and forward bypass controls must be operated in the AUTO mode at all times when above 80,000 feet. When inlet controls must be operated manually, maximum allowable speed is Mach 3.0.

CANOPY

The canopy shall be opened or closed only when the aircraft is completely stopped. Maximum taxi speed with the canopy open is 40 knots. Gusts or strong winds should be considered as a portion of the 40 knot speed limit.

LANDING GEAR SYSTEM

Landing Gear

Do not exceed 300 KEAS or Mach 0.9 with a maximum of 5° sideslip with gear extended. When sideslip angle exceeds 5°, operation with gear extended is limited to Mach 0.7 or 300 KEAS. Operation at supersonic speed with gear extended is prohibited. The landing gear is designed for landing sink speeds at touchdown which decrease from 9 FPS at 57,000 pounds to 5 FPS at 123,600 pounds. Side loads during takeoff, landing, and taxiing must be kept to a minimum, as landing gear side load strength is critical during ground maneuvering.

Tires

The maximum taxi speed recommended is 40 knots for Goodrich 27.5 x 7.5 x 16 "silver" tires. The rated ground speed limit is 239 knots. At 4500 feet elevation, 239 knots corresponds to 210 KIAS with 108°F ambient temperature on a calm day, and 226 KIAS at 32°F ambient temperature. Limit indicated airspeed on the ground decreases by the amount of tailwind component along the runway and increases by the headwind component. Refer to figure 5-7 for rated speeds at other altitudes and temperatures.

Taxiing Restrictions

A heat check is required for tires, wheels, and brakes:

a. Prior to takeoff when taxiing has exceeded one statute mile.

b. When continuous taxi distance has exceeded 5 statute miles.

c. When clear of the runway after an aborted takeoff or a heavy weight landing.

INITIAL BRAKING SPEED FOR STOP USING RATED BRAKE CAPACITY

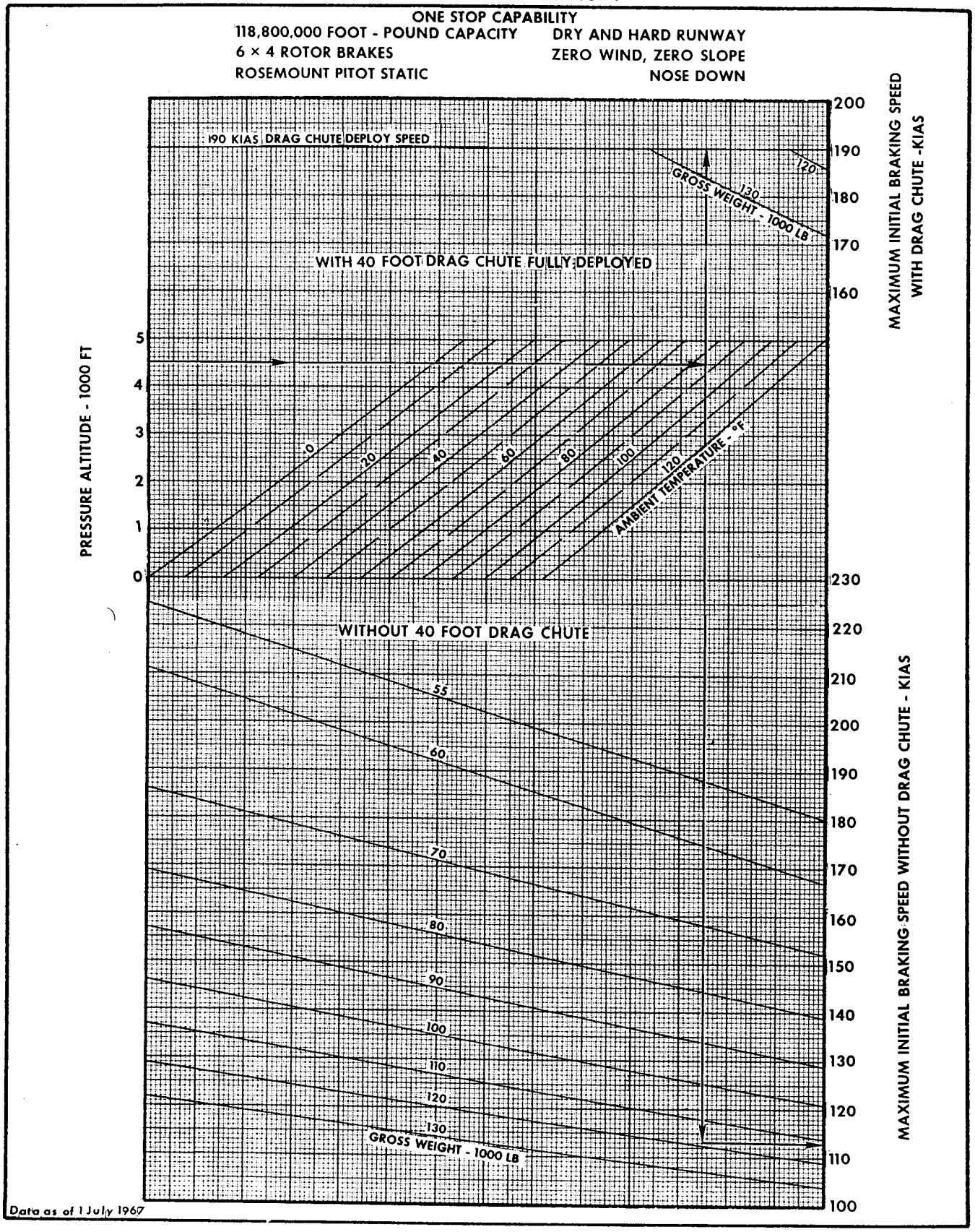

Figure 5-8

FLIGHT CHARACTERISTICS

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GENERAL

This aircraft operates within an exceptionally large Mach number and altitude envelope but the equivalent airspeed, angle of attack, and load factor envelope is relatively narrow. Typical takeoff and landing speeds are 210 and 145 knots respectively, and the cruise speed is approximately 1850 knots at 3.2 Mach number. Sustained cruise altitudes at high Mach number range from 74,000 feet to above 85,000 feet.

The aircraft is designed to obtain maximum cruise performance at 3.2 Mach number. The external configuration, air inlet system, power-plant and fuel system sequencing are optimized for this flight condition. A three axes stability augmentation system is an integral part of the aircraft control system design and is normally used for all flight conditions. The normal flight characteristic discussed in this section assume proper SAS operation, unless stated otherwise, and observance of the limits specified in Section V.

CONFIGURATION EFFECTS

External configuration features which affect flight characteristics include the delta wing, fuselage chines and the engine nacelle location.

The normal delta wing characteristics are present in these aircraft. There is no stall at normal operating speeds and flight attitudes, instead there is a large increase in drag as the limit angle of attack is approached. This characteristic of a delta wing can cause very high rates of sink to develop if the aircraft is flown at too slow a speed. The stall warning light is to limit the angle of attack to a safe value so that stall is not encountered.

The dihedral effect is positive, but diminishes at the higher Mach numbers. Roll damping is relatively low over the entire speed range of these aircraft and the lateral-directional qualities are relatively poor with SAS off.

The chines extend from the fuselage nose to the wing leading edge. At subsonic speeds they have the beneficial effect of increasing directional stability with increasing angle of attack. At supersonic speeds, they provide lift and eliminate a need for canard surfaces or special nose up trimming devices. The automatic fuel tank sequencing shifts the center of gravity aft during acceleration to correspond with the aft shift of center of lift with increasing Mach. Then it maintains c. g. at a relatively constant optimum location during cruise. This placement of the center of gravity close to the center of lift decreases pitch trim requirements and minimizes the thrust and fuel flow required for cruise. This also reduces the static longitudinal stability margin, but the SAS compensates for the reduction and provides satisfactory handling qualities.

The mid span location of the engines minimizes drag and interference effects of the fuselage. The inboard cant and droop of the nacelles gives maximum pressure recovery at the engine inlets at the angles of attack normal for high altitude supersonic cruise. However, the location results in sensitivity of the aircraft to asymmetric thrust conditions. During afterburner cruise, throttle and EGT trim adjustment to equalize fuel flows minimizes thrust differences. Engine EGT and fuel flow values should be matched by throttle adjustments during subsonic cruise. Indicated flows during non-afterburning operation may include heat sink system requirements after hot flight with low fuel remaining, so that flowmeter values may not be representative of engine consumption and thrust.

STABILITY CHARACTERISTICS

The augmented dynamic stability is positive and flight tests have demonstrated that the dynamic damping characteristics are essentially deadbeat. No unusual static stability characteristics have been disclosed when operating within the c. g. and angle of attack limits. Positive static stability continues to exist when c. g. is somewhat aft of the limit while at intermediate supersonic speeds (from Mach 1.2 to at least Mach 2.6.) However, if the aft c. g. limit is violated while near the design cruise Mach number, a static instability in pitch may be experienced. If pitch rates are then generated and not arrested within the angle of attack limit, a pitch up can develop and result in structural failure of the aircraft.

The aircraft is controllable without stability augmentation to Mach 3.2. Without SAS it is also controllable during climb and descent, during inlet unstart up to Mach 2.8 and 430 KEAS and during unstart and engine flame out up to Mach 2.5 and during twenty degree bank turns in heavy turbulence at

WING LIFT VS ANGLE OF ATTACK

BASIS: Wind Tunnel Tests
Rigid Airplane

NOTE: No wing stall experienced

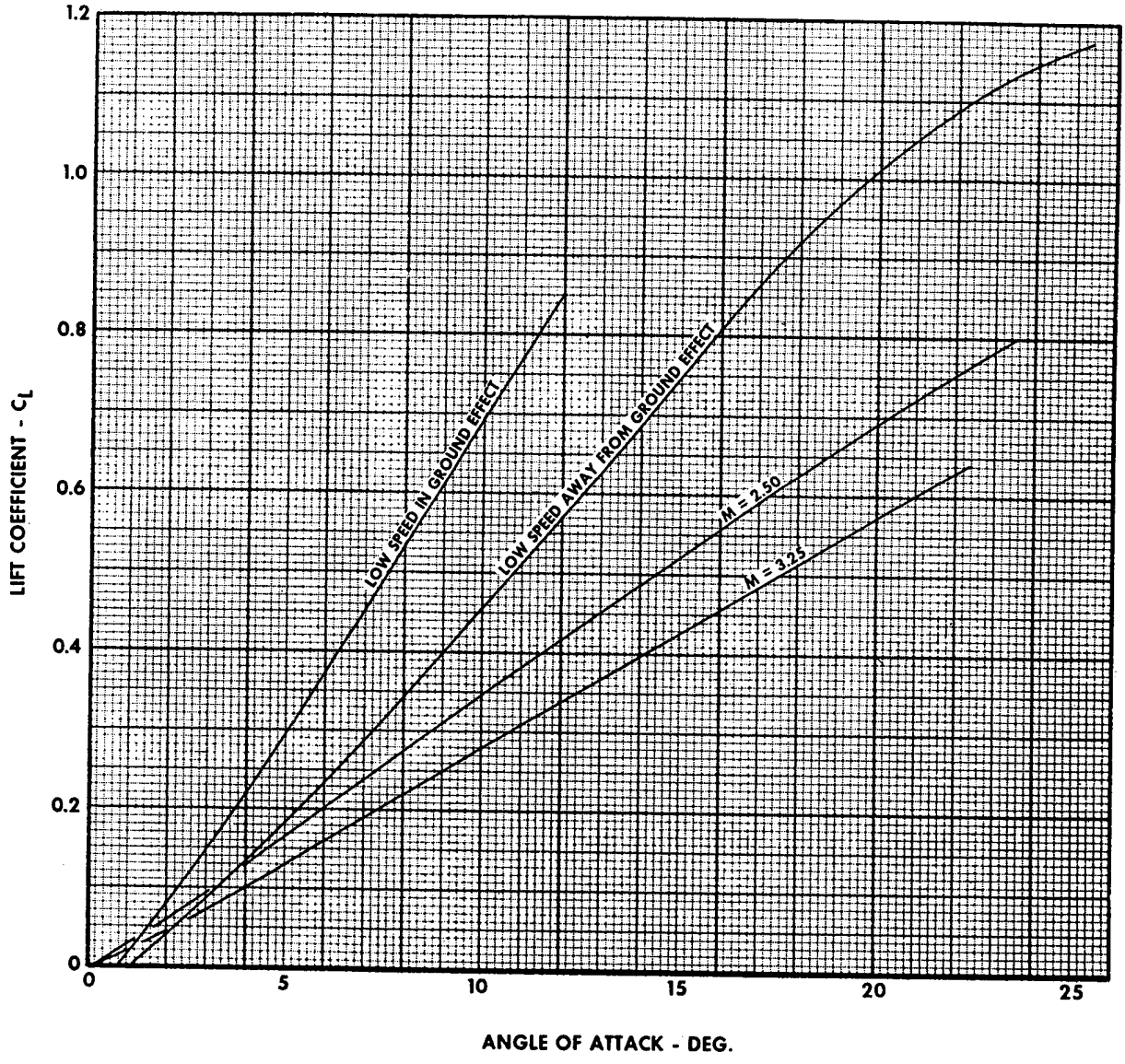


Figure 6-1

SUBSONIC - CRITICAL ANGLE OF ATTACK BOUNDARY

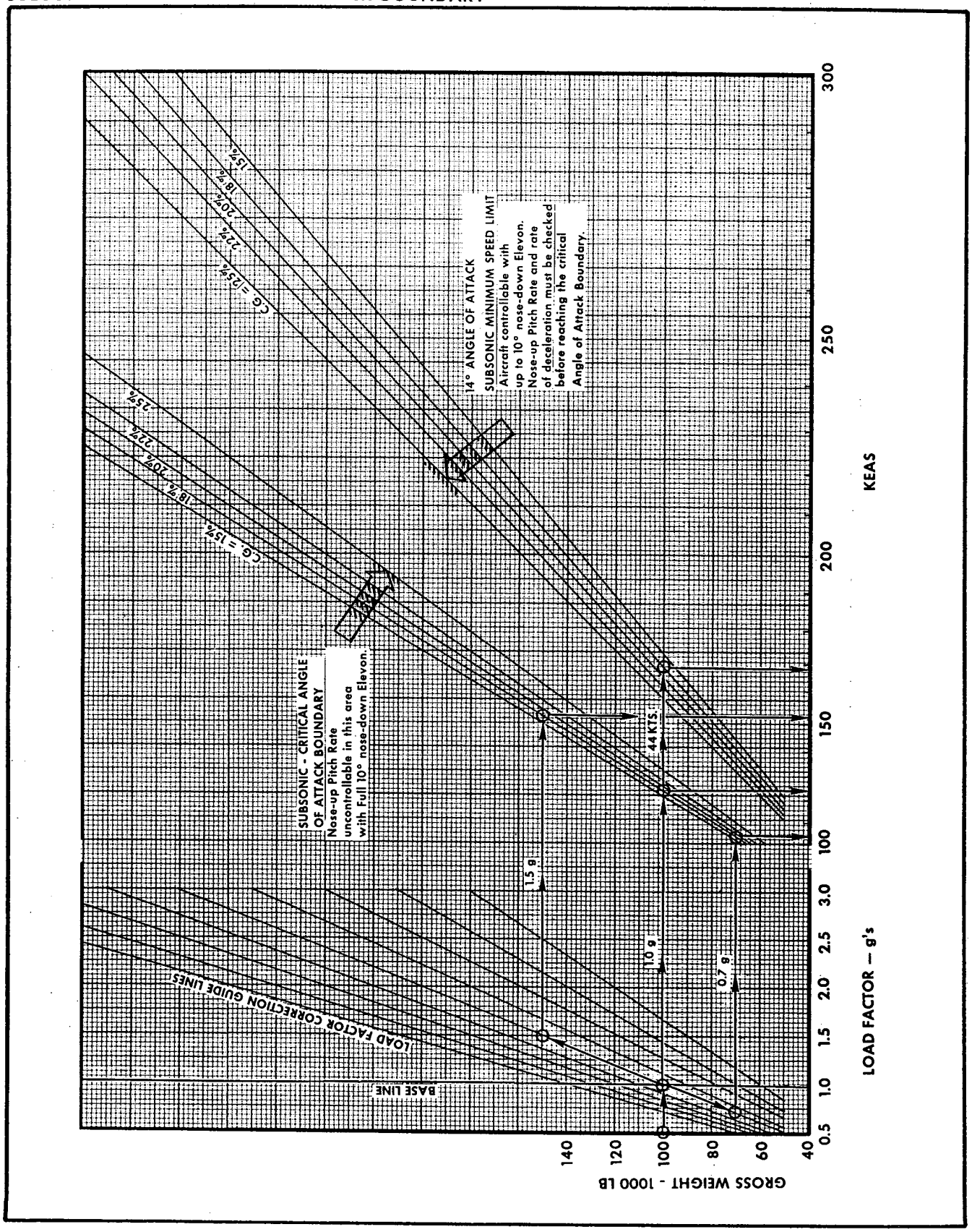


Figure 6-2

low supersonic and transonic Mach numbers. However, control with SAS off is sensitive and control movements should be kept to the necessary minimum. Thrust asymmetry should be minimized, particularly at the higher Mach numbers. Sustained cruise or maneuvering without pitch and yaw axis stability augmentation is not recommended near design speed.

At cruise Mach number, the pitch stability is only slightly positive and disturbances are only lightly damped. Sudden loss of all pitch SAS while in maneuvering flight will cause a pitch transient which will momentarily increase the load factor for the same stick position.

Without SAS the yaw stability may vary from positive to very slowly divergent. Response of the automatic air inlet system to yaw oscillation has a pronounced effect on directional motion of the aircraft. Unless controlled by the pilot, phasing of the spikes and forward bypass can tend to either drive or damp the yaw oscillations.

Emergency operating procedures for use in the event of SAS failure are given in Section III.

HIGH ANGLE OF ATTACK CONDITIONS

Minimum airspeed restrictions and a maximum angle of attack warning light are furnished to prevent approach to pitch-up conditions, and to maintain adequate ground clearance at takeoff and landing consistent with performance objectives. There is no stall in the classic sense where an abrupt loss in lift would occur at a critical angle of attack. (See Figure 6-1, Lift vs Angle of Attack.) A nose up pitching moment develops instead, as angle of attack increases, which becomes uncontrollable with full nose down elevon as the critical angle of attack boundary is reached. (See Figure 6-2, Subsonic Critical Angle of Attack Boundary.) An uncontrollable pitch-up will not occur until after limit angle of attack as given in Section V is reached. The SAS will tend to maintain apparent stability about all three axes until loss of control occurs, then the aircraft will pitch-up with little or no warning. Note that there is an airspeed margin of from 30 to 75 KIAS when subsonic and at the aft c. g. limit of 25% MAC. The margin is less at supersonic speeds and varies with Mach number. c. g. 's aft of normal limits will materially reduce the margin. When near limit angle of attack, a pilot induced rapid nose up pitch rate may require more margin for recovery than is available.

WARNING

An uncontrollable pitch-up maneuver will result when the critical angle of attack boundary is reached. Recovery from this condition is extremely unlikely. Attempted recovery must not be continued to the point where insufficient altitude for recovery or ejection exists.

Pitch rates which accompany increasing angles of attack must be checked and load factor relieved at a sufficient rate to increase airspeed when the critical angle of attack boundary is approached. When subsonic and terrain clearance permits, airspeed should be increased to 300-350 KIAS before resuming level flight. Care must be exercised to insure that recovery load factors will neither cause limit angle of attack to recur or impose load factors beyond allowable values. When supersonic and near limit Mach number, it may be necessary to reduce power or increase drag (or both) while recovering so that limit Mach number will not be exceeded while airspeed is increasing.

SPINS

Intentional spins are prohibited. The following technique is suggested in the event of an inadvertent spin; however, ejection may be the best course of action after considering existing altitude, airspeed, spin rate, attitude, and fuel loading conditions, as spin recovery has not be demonstrated and is considered extremely unlikely. At the pilot's discretion:

1. Center the controls, disengage surface limiters, and determine the direction of rotation from the turn indicator.
2. Apply forward stick and full roll control into the direction of spin as the nose drops.
3. Apply opposite rudder to stop rotation.
4. Center the rudder and roll control as rotation stops.
5. Start pull-out at 300 to 350 KIAS.
6. If possible, avoid exceeding 450 KIAS and limit load factor during recovery.

WARNING

With uncontrollable conditions, eject at least 15,000 feet above the terrain whenever possible.

CONTROL EFFECTIVENESS

Generally control effectiveness is good. At high altitude and angle of attack roll control effectiveness is reduced. This is only a problem if an unstart occurs in the down inlet in a turn. Refer to Inlet Duct Unstarts, Section III.

SINGLE ENGINE

The yawing moment resulting from asymmetric thrust is large if an engine fails just after takeoff or a single engine go around is necessary. Approximately 2/3 to full rudder deflection and 10 degrees or more bank into the good engine will be necessary to maintain control immediately after loss of power. Drag can then be minimized by reducing pedal force and trimming to 7° to 9° rudder position indication, simultaneously using bank and sideslip toward the operating engine as necessary to maintain the desired flight path. The SAS automatically responds with corrective control at the time of engine failure or go around power application and its response rate is faster than pilot reaction time. However, rudder control follow up by the pilot is necessary as the yaw SAS authority is limited to 8 degrees rudder deflection. The SAS continues to apply rudder deflection as long as a sideslip is maintained, but this deflection is not indicated by pedal position or by the rudder trim indicator.

The amount of rudder deflection required during single engine operation decreases as airspeed is increased. During single engine cruise at 0.5 to 0.85 Mach number, the aircraft can maintain course with surface limiters engaged. Optimum rudder deflections are maintained by the SAS without using rudder trim when bank and sideslip toward the operating engine are used to maintain course. The bank angles required approach 10°.

Above Mach 2.8, engine failure, flameout or inlet unstart may require yaw axis stability augmentation to avoid excessive sideslip and bank angles which could cause the operative engine to stall or flameout. Inlet unstarts while at 450 KEAS and maximum power are quite severe. In these cases, unassisted pilot reaction is too slow to provide all the control immediately required. Pilot follow up is necessary after the initial SAS corrections.

NOTE

Before retarding the throttle to shutdown an engine, care must be exercised to properly identify the side on which the malfunction occurred. There have been cases where the operative engine was improperly identified as the source of the problem.

NORMAL OPERATING CHARACTERISTICS

Refer to Appendix I for specific performance information.

Takeoff

The aircraft accelerates rapidly to rotation speed once maximum thrust is set during takeoff. The nosewheel can be lifted 50 to 60 knots below takeoff speed, but this is not advised because the drag that is created decreases the acceleration and extends the takeoff run. With zero degrees pitch trim, a stick force of approximately 25 pounds is normally required to lift the nosewheel at rotation speed. Stick force must be relaxed during the rotation in order to check the nose up pitch rate. During maximum performance takeoffs, speed and attitude must be monitored carefully to avoid overrotating and dragging the tail.

Climb

Normal climbs to supersonic cruise speeds involve three phases of operation. These consist of a subsonic climb, a transonic acceleration to the supersonic climb schedule, and a supersonic climbing acceleration.

There are no unusual characteristics during the subsonic phase except that a light airframe buffet may be felt near 0.9 Mach number as airflow conditions near the tertiary doors and ejector flap areas change

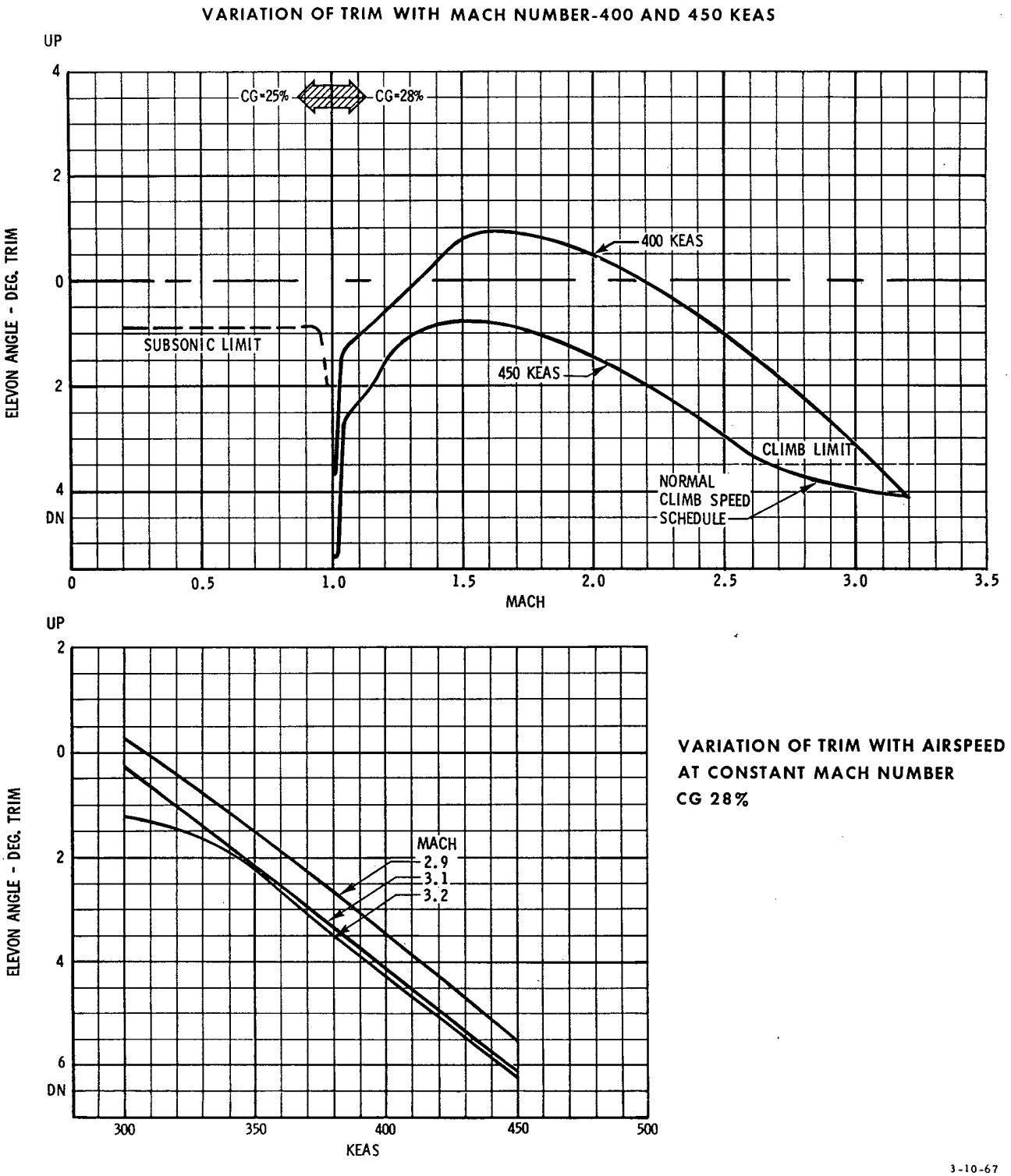
A Mach jump on the TDI instrument will be observed between 0.98 and 1.03 Mach number during transition to the supersonic climb speed schedule. No unique characteristics occur in this area; however, there is an area of decreased excess thrust from Mach 1.05 to Mach 1.15. A dive technique is used to improve acceleration through this speed range. The transition should be made without other maneuvering if possible, as even shallow turns increase drag sufficiently to decrease acceleration and increase fuel consumption considerably. A noticeable increase in acceleration can be expected after passing Mach 1.15. The pull up to establish climb attitude should be started 10-25 knots before the supersonic climb speed schedule is attained. This will reduce the possibility of overshooting the desired speed.

The supersonic climb is initiated when climb airspeed is established at approximately 30,000 feet. It is essential to maintain the schedule accurately to achieve best climb performance. Speeds which are higher than normal should be avoided because limit airspeed can be approached inadvertently in a short period of time.

The aircraft does not respond immediately to small pitch commands. This characteristic makes precise airspeed control difficult until experience is gained in the aircraft. If significant overspeed occurs, the recommended action is to reduce power until climb speed can be reestablished rather than pull up sharply and impose load factors.

ELEVON REQUIRED TO TRIM

ELEVON REQUIRED TO TRIM AT THE AFT CG CONDITION



VARIATION OF TRIM WITH AIRSPEED AT CONSTANT MACH NUMBER CG 28%

3-10-67
F200-95(a)

Figure 6-3

A continual variation in trim is required during the acceleration to cruise speed, with the 450 KEAS schedule requiring more nose down trim than the 400 KEAS schedule. The variation of trim at the aft limit is illustrated by figure 6-3. This figure also shows the variation of trim required with airspeed when operating near the aft c.g. limits.

Occasional periods of inlet roughness may be encountered in the area between Mach 2.5 and 2.8. It may also be encountered at climb speeds in the region above Mach 3.0; however, the roughness diminishes as cruising altitudes are reached and the equivalent airspeed is reduced from the climb airspeed schedule.

The transition to cruise altitude and speed is accomplished with power being reduced slowly as the initial cruise altitude is approached.

Cruise

The following definitions have been adopted in order to categorize supersonic cruise operation.

a. Maximum range (optimum) cruise profile - This type of operation yields maximum range for the Mach number specified. Power settings used are in the lower portion of the afterburner range (near the 82° PLA throttle mark).

b. High altitude cruise profile - This type of operation yields altitude schedules which are above the maximum range and below the maximum ceiling profile. The specific range which results is less than for maximum range, but reasonably efficient cruising schedules are maintained.

c. Maximum ceiling profile - This type of operation requires continuous operation at near maximum afterburner power setting for the Mach number specified.

These types of operations employ a cruise climb that requires a gradual but continuous increase in altitude as fuel is consumed. The flight parameters are: Mach number, equivalent airspeed (KEAS) and altitude. These three variables are dependent upon one another. Gross weight, ambient temperature, and c.g. also have primary effects on performance capability.

Mach, KEAS, Altitude Relationship

The selection of the values for any two of the Mach, KEAS, or altitude variables automatically defines the value of the third. For instance, if cruise is scheduled for Mach 3.1 and the desired cruise altitude is initially 73,500 feet, the KEAS must be 395 knots.

Effect Of Changing Air Temperature

Ambient air temperature may appear to change abruptly as different air masses are encountered because of the high true airspeeds at cruise. Initially, if constant altitude is maintained, flight into a warmer air mass will cause a decrease in Mach number and KEAS, and the true airspeed (TAS) and compressor inlet temperature (CIT) will remain constant for a short time. A higher TAS and CIT will result as the desired Mach number is re-established. The opposite would occur as a result of flying into a colder air mass. New cruise altitudes are usually required to compensate for effects of variations in ambient air temperature.

Effect Of Mach Number

Another characteristic of supersonic cruise is that any given gross weight and CIT, the altitudes for maximum range or maximum ceiling profiles increase with Mach number. As a rule of thumb, this increase is approximately 1000 feet per 0.05 Mach number. A related characteristic is that if the Mach number is allowed to increase slightly above that desired, and if the throttle is not retarded, the aircraft has an increasing amount of excess thrust. It is easy to exceed target Mach number inadvertently.

Maximum Range (Optimum) Cruise Profile

At high Mach numbers, the maximum range (optimum) profile is a continuous cruise climb with the throttles in the afterburner range near the 82° PLA throttle mark. When at heavy weight, it may be necessary to initiate this type of profile by flying at a constant altitude for a short period, slightly higher than the altitude for best specific range, in order to maintain KEAS at or below maximum operating limits. In this case, the initial cruise altitude schedule remains above the optimum until gross weight is reduced sufficiently to allow establishment of a cruise climb. Cruise climb should not be continued above 85,000 feet (because of present operating restrictions).

Turns

Constant altitude turns with 30° bank angle can normally be made by increasing thrust. As a rule of thumb, fuel flow and angle of attack increase in proportion to load factor. It is more economical to allow altitude to decrease while turning, maintaining constant power setting and Mach number during the turn, and regaining the altitude lost upon rolling out. KEAS should not be allowed to increase above the maximum operating limits during descending turns.

Maximum Ceiling Profile

The maximum ceiling profile is 5000 to 6000 feet above the altitude schedule for maximum range. See Figure 6-4. Stabilizing the aircraft on a cruise climb profile wherein the aircraft is constantly flying at its absolute ceiling at maximum afterburner is very difficult. The only control the pilot has to maintain constant Mach number is to climb or descend. Therefore the maximum practical altitude can be obtained by using slightly less than full power.

High Altitude Cruise Profle

High altitude cruise profiles schedule the cruise climb altitude below the maximum afterburning ceiling. Continuous use of maximum afterburner is not required.

Effect Of Mach Decrease

The Mach number must not be allowed to decrease more than 0.05 Mach number below the desired cruise speed. A small decrease in Mach number and KEAS at constant altitude may cause the aircraft to intercept the ceiling for that speed and become thrust limited. A descent of several thousand feet may be required to re-establish the desired cruise Mach number.

NOTE

Refer to Figure 6-4 for a summary of maximum range and ceiling altitudes for various Mach numbers, weights and ambient temperatures.

High Altitude Turn Technique

Turns Less Than 100°

The techniques described below minimize altitude variations while turning and abnormal altitude losses which can be encountered if turns are initiated near the maximum afterburner ceiling for the existing Mach number, gross weight and ambient temperature.

NOTE

Mach 3.2 is the target speed recommended for turning when maximum altitude is the primary consideration.

c. When turn entry is scheduled from a high altitude cruise profile when at light weight and using partial afterburning for power settings:

1. Prior to turn, cruise at power required to maintain target Mach number at desired altitude. Mach 3.2 is recommended when minimum altitude loss is the primary consideration.

2. Turn Mach Hold OFF and leave the autopilot Attitude Hold mode engaged.

3. Enter the turn with throttles set below maximum afterburning. While turning, adjust the throttles as required to control Mach number and adjust the autopilot pitch trim wheel to control altitude. Cruise altitude can be maintained in most cases.

Note

Do not make abrupt pitch attitude changes.

4. After 30° of turn, allow altitude to increase 1000 feet if sufficient excess thrust is available.

5. After completing the turn, engage Mach Hold to maintain the desired cruise climb schedule, and use power as required.

Descent

Descent characteristics are not unusual except for the variation in flight path angle encountered during the supersonic deceleration. Normal deceleration techniques include maintaining an optimum KEAS schedule to obtain maximum range and prevent exceeding engine cooling limitations. When cruise KEAS is higher than optimum, altitude should be maintained after power reduction until KEAS decreases. When cruise KEAS is lower than optimum, descent should be started immediately after power reduction, maintaining cruise Mach number until desired KEAS is intercepted. The angle of descent varies from approximately 1° initially to approximately 7° as Mach 1.0 is reached.

Air Refueling

Air refueling of these aircraft with the flying boom system of the KC-135 tankers poses no problem of compatability and is normally accomplished between 25,000 and 32,000 feet. The aircraft provides an extremely stable platform with the SAS on. The only characteristic that causes some problem is that, without afterburning, the aircraft may become power limited at the higher refueling altitudes before a maximum onload can be completed. This requires using either a toboggan technique or a technique of completing the refueling with one afterburner on.

Forward visibility in the observation and precontact positions is excellent, but upward, downward, and aft visibility is restricted. Rendezvous is easiest from a slightly low position with the tanker within 60° either side of the nose. The pilot's refueling visibility is optimized by lowering his seat prior to contact. Depth perception through the vee windshield is slightly impaired, and some pilots may prefer to use one side of the windshield during contact.

A slight buffet will be felt as the contact position is reached. This is tanker downwash and has no effect on the receiver except for a slight decelerating effect. Acceleration response of the engines is excellent, and aircraft drag at refueling speeds produces correspondingly good deceleration response.

Overcontrol of the engines should be avoided while gaining and holding position due to nonlinearity of throttle position vs engine thrust. A given throttle angle change near military power yields more thrust change than a similar change in the throttle mid range. The aircraft may become power limited if the afterburner-on technique is not used, and tobogganing descents of up to 1000 feet

per minute may be required as the military power throttle position is approached. Asymmetric thrust is easily controlled when the afterburner-on technique is used.

Light turbulence encountered while in contact poses no particular problem with SAS operating normally, and shallow turns of up to 20° bank angle can be made without difficulty. However, if all pitch SAS including the back-up pitch damper are inoperative, it is recommended that refueling not be attempted except in an emergency. The aircraft tends to be unstable without any pitch SAS, but control can be maintained under favorable conditions with fuel transferred to obtain a forward c.g. location.

All disconnects should be made with a rearward and slightly downward relative motion with wings level. This will insure separation of the boom from the receptacle with a straight line force. Side or rolling loads or excessive deviations from the desired elevation increase the possibility of boom and/or receptacle damage during disconnect.

Night refueling is essentially the same as for daytime operations except that added caution and effort is required to avoid overshoot, and the tendency toward throttle over-control while in contact is increased.

Approach and Landing

Handling characteristics during approach and landing with SAS operative are good. Short period disturbances are well damped, and rates of roll available for maneuvering are adequate. The aircraft can be held off the runway to speeds that are much lower than are recommended for landing. The touchdown attitude normally is from 10° to 12° angle of attack. There is a risk of damage to the aft fuselage if the touchdown attitude exceeds 14°.

Normally the aircraft is flown directly to touchdown rather than attempting to float just off the runway with subsequent settling at too high an attitude. Prompt chute deployment will result in momentary deceleration loads of up to one g. The chute should not be deployed in the air because of the rapid deceleration and rate of sink that could develop, but it can be actuated before nosewheel contact without any unusual pitching tendencies.

Practice landings with SAS off are not recommended. Approach control during emergency landings with all pitch SAS off is increasingly more difficult if c.g. approaches or exceeds the aft limit.

SYSTEMS OPERATION

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ENGINE

ENGINE TRIMMING

On many engines, engine trim adjustment can be accomplished only on a test stand or while the aircraft is on the ground. One of the features affecting operation of these aircraft is an engine trim device which is operated from the cockpit. The trimmer is normally used to maintain EGT within a recommended operating range in flight when at or near Military thrust or when the afterburner is operating. It modifies the turbine inlet temperature vs compressor inlet temperature scheduling characteristics of the main fuel control. Changes in engine trim are indicated by the EGT gage. Trimming has little direct effect on afterburner operation, but the trimmer is the only main engine control available to the pilot when a throttle is set in the afterburner range.

NORMAL EXHAUST GAS TRIM TEMPERATURE

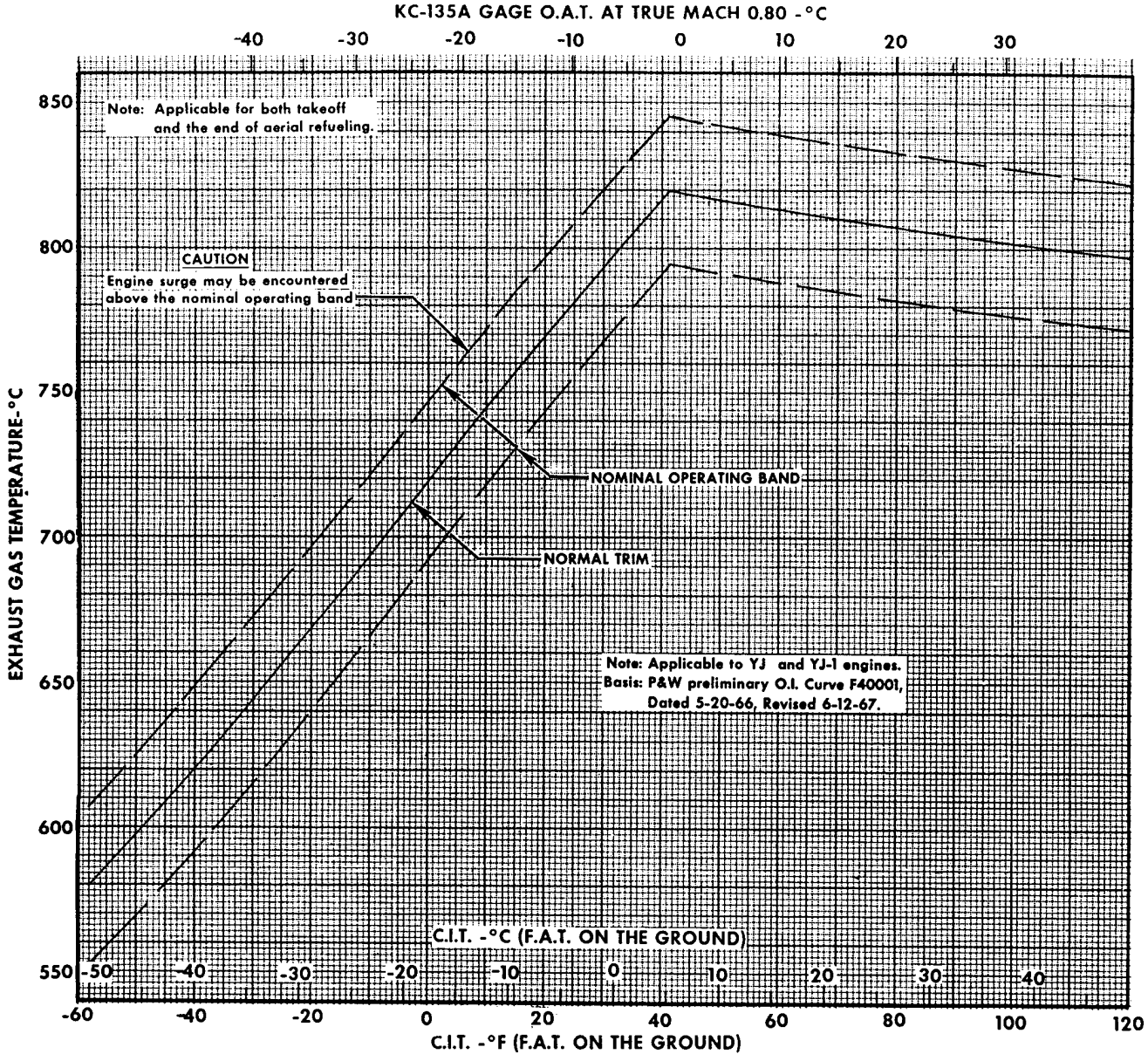

KC-135A GAGE O.A.T. AT TRUE MACH 0.80 - °C
-40 -30 -20 -10 0 10 20 30
Note: Applicable for both takeoff and the end of aerial refueling.
CAUTION
Engine surge may be encountered above the nominal operating band
NOMINAL OPERATING BAND
NORMAL TRIM
Note: Applicable to YJ and YJ-1 engines.
Basis: P&W preliminary O.I. Curve F40001, Dated 5-20-66, Revised 6-12-67.
EXHAUST GAS TEMPERATURE-°C
850
800
750
700
650
600
550
C.I.T. -°C (F.A.T. ON THE GROUND)
-50 -40 -30 -20 -10 0 10 20 30 40
-60 -40 -20 0 20 40 60 80 100 120
C.I.T. -°F (F.A.T. ON THE GROUND)

Figure 7-1

NORMAL TRIM OPERATION

The following describes the normal use of trim capability at the present time.

Prior to Takeoff

A trim run is usually made on the end of the runway prior to takeoff using the following procedure:

1. Wheels - Check chocked.
2. Throttles - MILITARY momentarily then IDLE.

   This serves to unload the trimmer and reduce hysteresis.
3. Throttles - MILITARY until EGT stabilizes.

4. EGT trim switches - As required per figure 7-1.

5. Throttle - IDLE rapidly.

   This throttle chop serves to check the proper sequence of bleed operation by the absence of compressor stall.

Climb and Cruise

Trim as necessary after takeoff and while accelerating to 60°C CIT to maintain EGT less than 845°C. EGT must be maintained below 805°C when above 60°C CIT. It is recommended that the EGT be maintained between 775°C and 805°C during cruise.

Subsonic Operation

The engine fuel control is scheduled to reduce turbine temperature rather rapidly as compressor inlet temperature falls below 5°C to preclude the possibility of engine stall. The EGT trim may be used in this operating regime to up trim the engine if required. It may be possible to increase the EGT more than 50°C but in most cases the increase will be less since the uptrim range is a function of the original trim setting.

WARNING

Uptrimming in the low temperature area can cause over temperature during subsequent aircraft acceleration or above 5°C CIT unless the EGT trim is reset to nominal schedule prior to acceleration.

Effect of Engine Thrust Variation with EGT

Figure 7-2 illustrates the typical variation of engine thrust with EGT at scheduled rpm, Mach 3.2 and 80,000 feet. For a given level of thrust, higher throttle settings and increased fuel flow are required as EGT is decreased. Full throttle ceilings in cruise and while turning are reduced; this occurs because combined burning efficiency of the engine and AB decreases with lowered EGT. The degradation in thrust for all throttle settings, at Mach 3.2 and 80,000 feet, is approximately 1.3 percent per 10°C of EGT decrease. Although only one flight condition is illustrated, the trend is the same for other flight conditions.

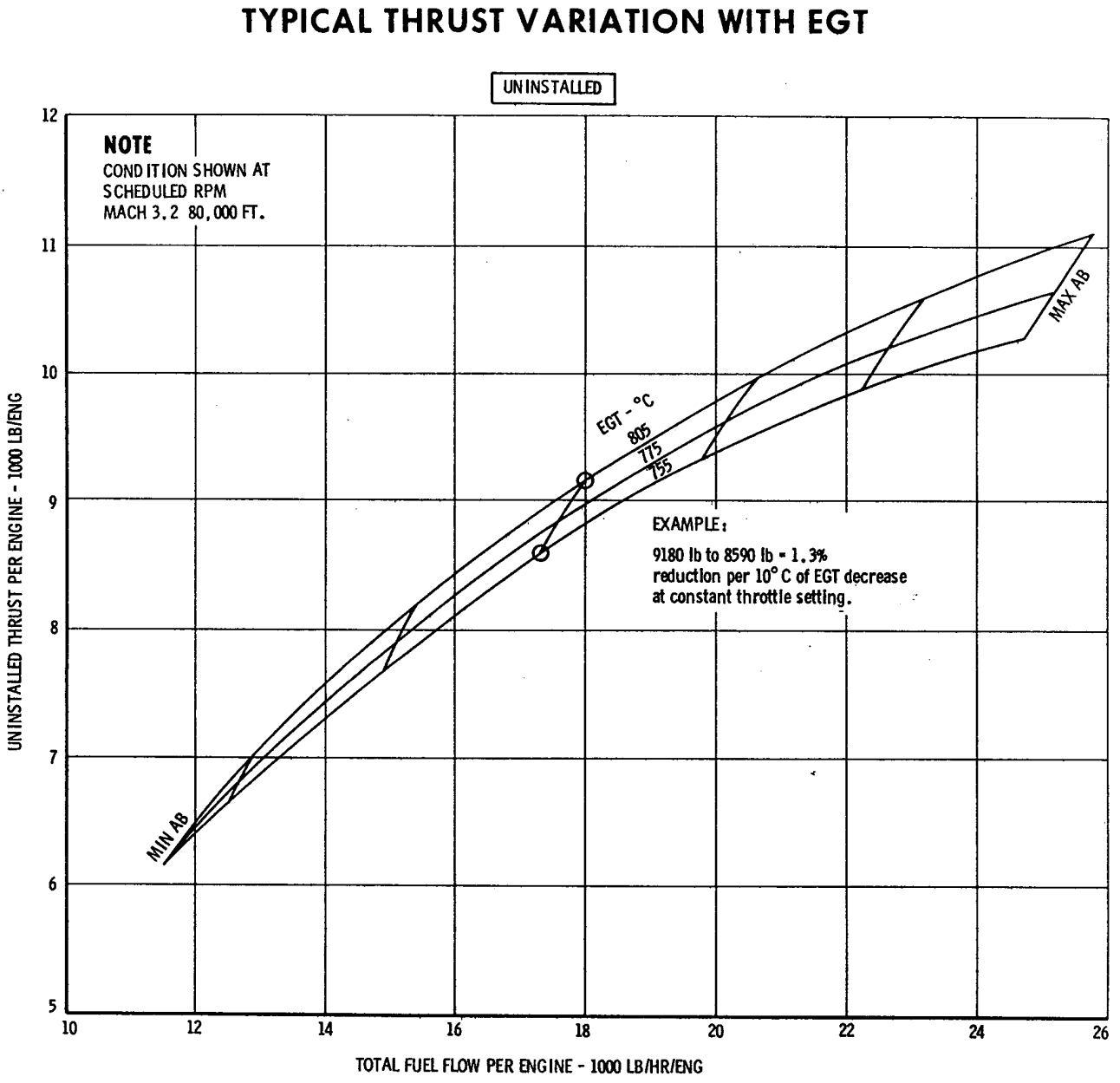
Effect of RPM Suppression on MAXIMUM THRUST

As EGT decreases, the engine nozzle opens to maintain scheduled rpm. At high Mach number and maximum power, low EGT may cause the nozzle to open fully and any further EGT decrease will result in rpm suppression below schedule. When this condition occurs the engine speed will suppress approximately 50 rpm for each 10°C of EGT decrease. The airflow through the engine decreases due to the suppressed rpm, leading to a higher inlet duct bypass requirement and opening of the forward bypass doors. At Mach 3.2 this results in a thrust degradation and drag increase of approximately 3.5 percent per 10°C of EGT decrease for each affected engine. If Mach number decreases as a result of the change in thrust and drag, the spikes schedule more forward and the forward bypass doors open further. Performance will deteriorate rapidly under these cumulative effects and it is recommended that cruise EGT be maintained between 775°C and 805°C to avoid the possibility of this situation occurring.

After Air Refueling

The KC-135 crew can advise the pilot of the proper engine trim to be set when the air-

TYPICAL THRUST VARIATION WITH EGT



F200-87

Figure 7-2

craft departs the tanker. Figure 7-1 provides engine exhaust gas temperature vs KC-135 indicated free air temperature.

NOTE

If an EGT increase between Military and maximum afterburning power exists the pilot should also be briefed on the amount of EGT increase.

TRIMMING WITH SURGE SENSITIVE ENGINES

Some engines have surged during ground operation while at turbine discharge temperatures (EGT's) specified for takeoff by the respective EGT trim curves. This tendency to surge, when it appears, is greater at lower ambient temperatures. Surge sensitive engines have not exhibited this problem in flight. Most of these engines can be identified prior to flight; however, engines with no previous surge history have developed into surgers after exposure to descents from high Mach numbers.

If an engine surges during pre takeoff trim, down trim to eliminate surge but do not trim lower than 60°C below the desired trim point for the ambient temperature.

NOTE

- Surging is a ground run problem only.
- Engine thrust is reduced about 210 pounds at sea level static for each 10°C of EGT down trim from the normal trim curve. After takeoff engines down trimmed for surge protection should be up trimmed to 775°C EGT when CIT reaches 0°C.

INLET OPERATION

SPIKE AND BYPASS CONTROL

1. When an inlet unstarts above approx. 2.0 Mn.
2. During normal scheduling as Mach decreases to 1.6 Mn, or with variations in angle of attack or yaw angle.
3. When descending past approximately 30,000 feet.

Spike is moved forward if the spike knob is not in AUTO:

1. If FWD position is selected.
2. If 1.4 position is selected.

Spike is moved forward under the following conditions:

1. The restart switch is actuated to ON.
2. If L or R hydraulic pressure to the spike actuator fails below Mach 1.6 and at higher Mach number unless the inlet is unstarted.
3. (On the left side) the number 2 inverter fails, the L SPIKE & DR ICS circuit breaker opens, or if the L SPIKE & DR LVDT circuit breaker opens.
4. (On the right side) the number 3 inverter fails, the R SPIKE & DR ICS circuit breaker opens, or the R SPIKE & DR LVDT circuit breaker opens.
5. The emergency spike forward switch is actuated to the forward position following confirmed loss of hydraulic pressure.

Forward bypass opens or moves toward open when the control knob is in AUTO under the following conditions:

RANGE OF CIP OPERATING PRESSURES

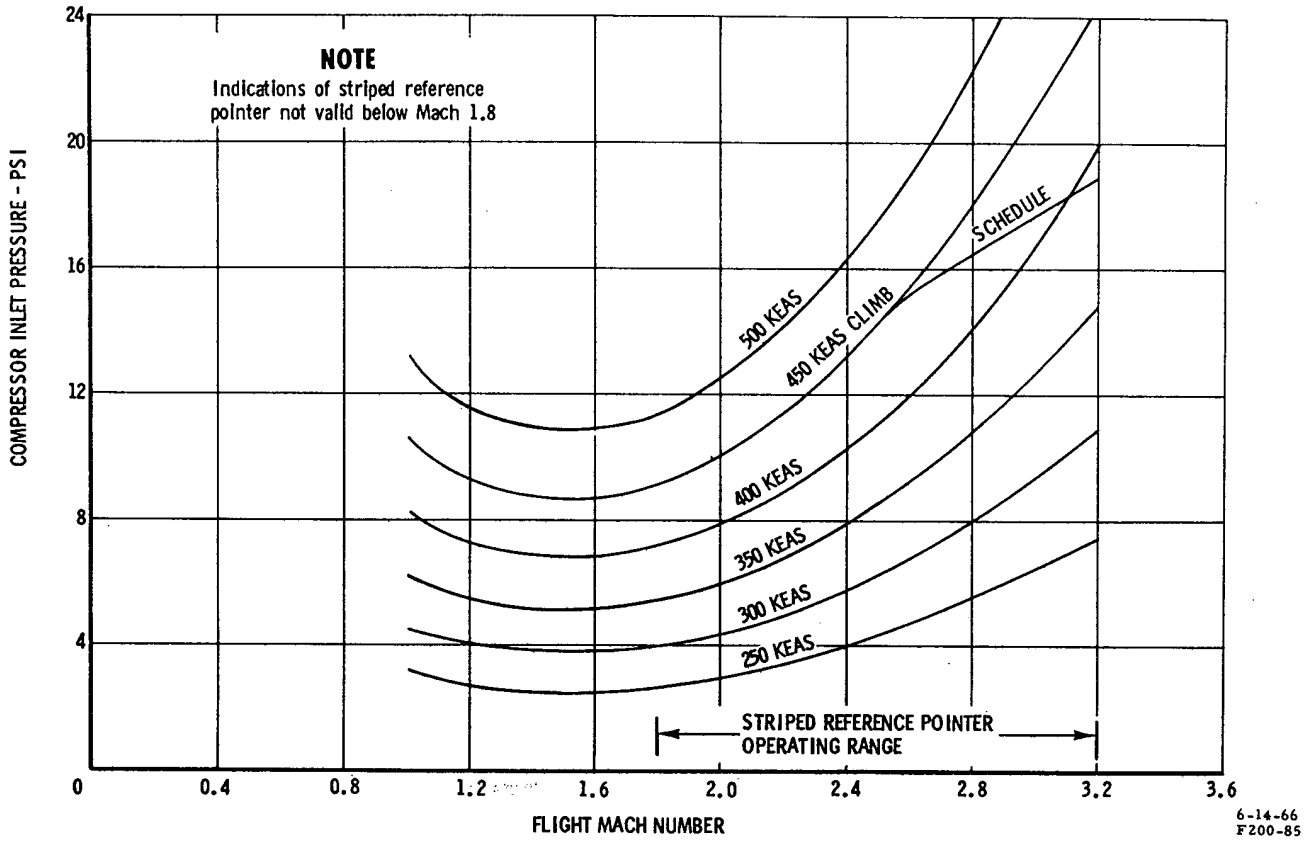


Figure 7-3

1. When an inlet unstarts above 2.0 Mn.
2. Per the automatic schedule.
3. During periods of rapid RPM decrease.
4. When manual spike is selected.

The forward bypass opens or moves toward open when the forward bypass control is not in AUTO under the following conditions:

1. As a lower number position or OPEN is selected.
2. As a function of the manual spike knob position selected, up to approximately one inch of door opening variation.
3. Restart switch is actuated to ON or forward bypass open.
4. The L or R hydraulic pressure to the door actuator fails.
5. (On the left side) the number 2 inverter fails, the L SPIKE & DR ICS circuit breaker opens.
6. (On the right side) the number 3 inverter fails, the R SPIKE & DR ICS circuit breaker opens, or the R SPIKE & DR LVDT circuit breaker opens.

7. The main landing gear doors are open.

The forward bypass is closed when the speed is below Mach 1.4, except when the main landing gear doors are open.

CIP INDICATIONS

The position of the third striped pointer on the CIP gage is controlled by an output signal from the air data computer from pressures sensed by the pitot static system. The indication is scheduled in accordance with automatically computed values of Mach number and KEAS so that the striped pointer shows a "normal" CIP (± 1.1 psia) (see figure 7-4) for the flight condition if over 250 KEAS and Mach 1.8. Values indicated while at lower speed conditions are not intended to be representative of normal inlet pressures. Above the minimum speed range a substantial difference between the "normal" and actual CIP pointer indicates improper inlet operation. Higher actual pressures than "normal" indicate possible unstart conditions. Lower than normal actual pressures indicates poor pressure recovery due to improper spike and/or bypass settings except when at abnormal angles of attack or in yaw conditions where inlet operation is automatically biased to produce less than normal recovery. The normal spread between CIP indications (L & R pointers) should not exceed 1 psi. The difference between either L or R pointer and the striped pointer should not exceed 1 psi. The striped pointer may be used as a guide for bypass door settings during manual operation of one or both inlets and it is preferable to keep the L and/or R pointer slightly below the "normal" indication to maintain a margin below unstart pressures. Continued automatic or manual inlet opercation at pressures substantially below the "normal" indication can result in loss of aircraft range.

NOTE

As the total tolerance of the striped pointer can be as much as ± 1.1 psi at maximum Mach number, it is possible for a properly operating inlet to be above the "normal" indication.

FUEL SYSTEM OPERATION

NORMAL FUEL TANK SEQUENCING

The normal sequence of fuel usage with the aircraft fully fueled is completely automatic. After tank 1 fuel is used, this automatic sequencing maintains c. g. in the range from 25.5% to 26.9% MAC for optimum high speed cruise at altitude. Starting, taxi and takeoff are normally accomplished with the pumps in tanks 1, 2, and 6 feeding the engines. Tank 1 normally empties during climbout or shortly after supersonic speeds are reached, then tank 2 continues feeding the left engine and tank 6 the right engine. As tank 2 approaches empty a float switch starts the pumps in tank 3. When tank 2 becomes empty, a second float turns off the tank 2 pumps. Any residual fuel in the tank is pumped into tank 3 by the jet pump system. The float switch on tank 6 turns on the pump in tank 5 and the second (empty) float switch turns off the tank 6 pumps. As tank 3 approaches empty the two pumps in tank 4 feeding the left manifold are started and as tank 5 approaches empty the other two pumps in tank 4 feeding the right manifold are started. Aft transfer of fuel to tank 6 to control c. g. is accomplished automatically through the left manifold. Aft transfer occurs at any time when tank 6 pumps are on, space is available, tank 2 fuel is above the 2400-6000 pounds level as shown on figure 7-4 and both throttles are in the afterburner position. When aft transfer is in operation, tank 1 is feeding and tank 6 is nearly full the maxi-

GROSS WEIGHT VERSUS C.G.

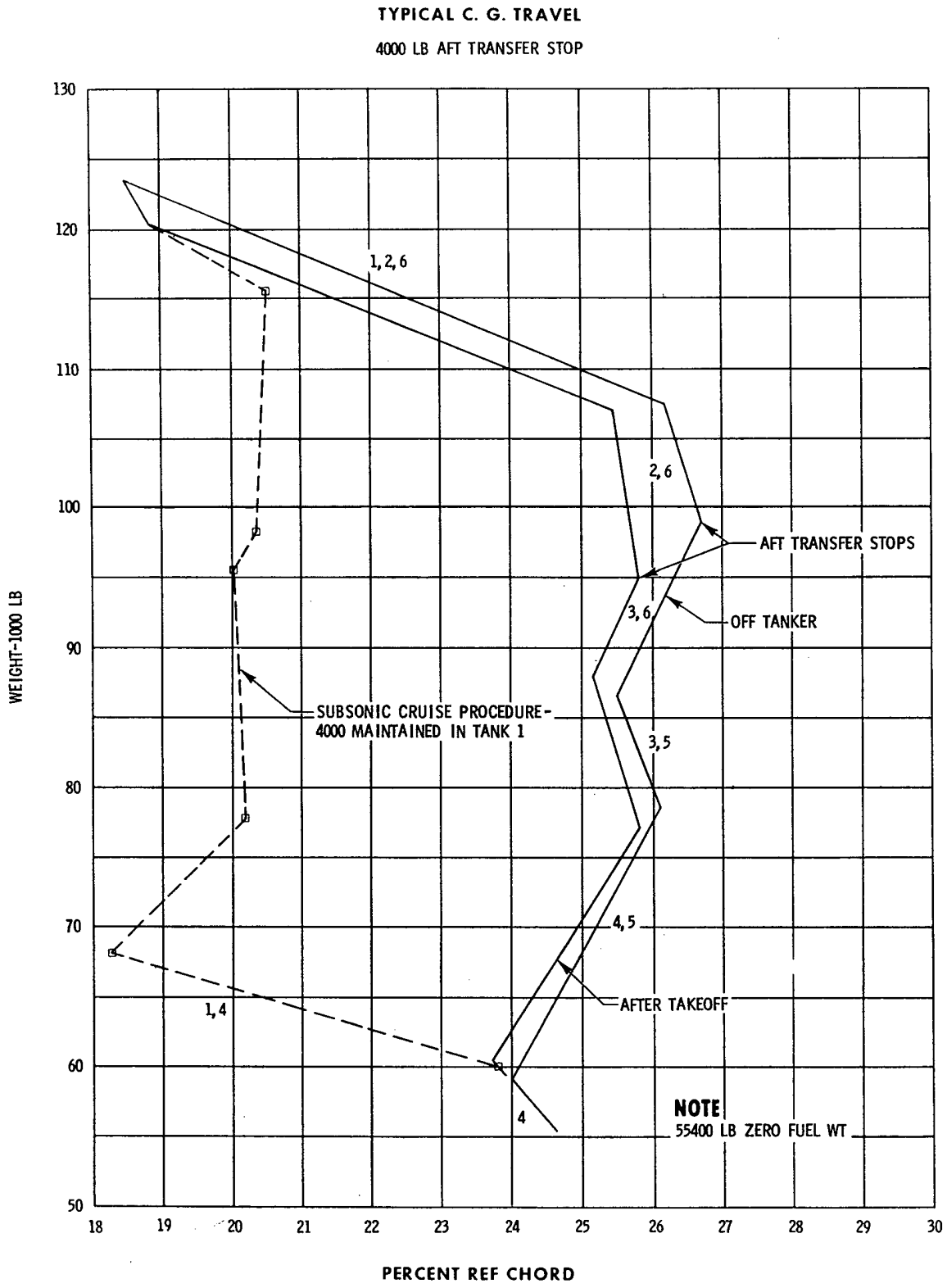


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Figure 7-4 (Sheet 1 of 3)

GROSS WEIGHT VERSUS C.G.

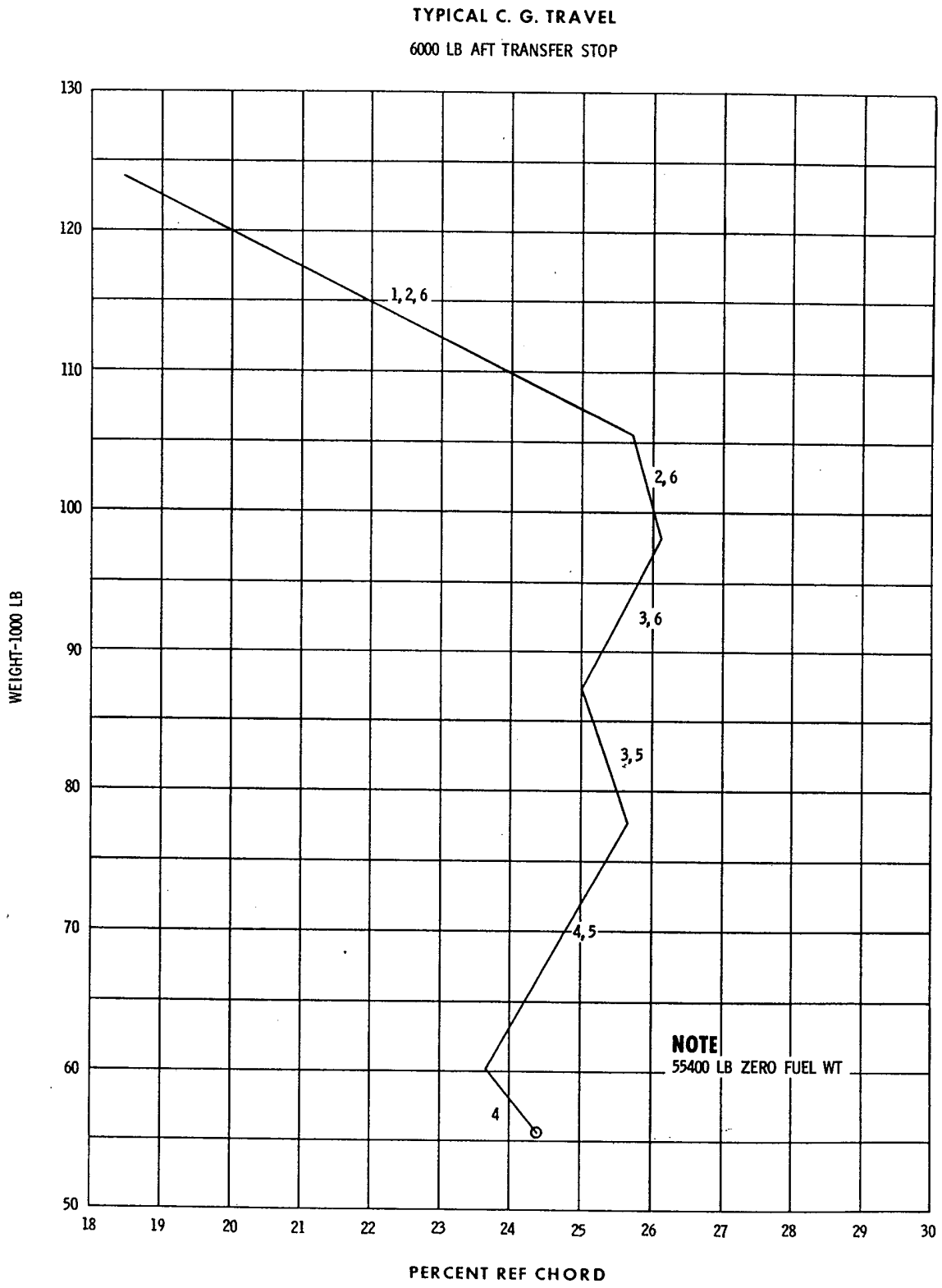

Figure 7-4 (Sheet 2 of 3)

GROSS WEIGHT VERSUS C.G.

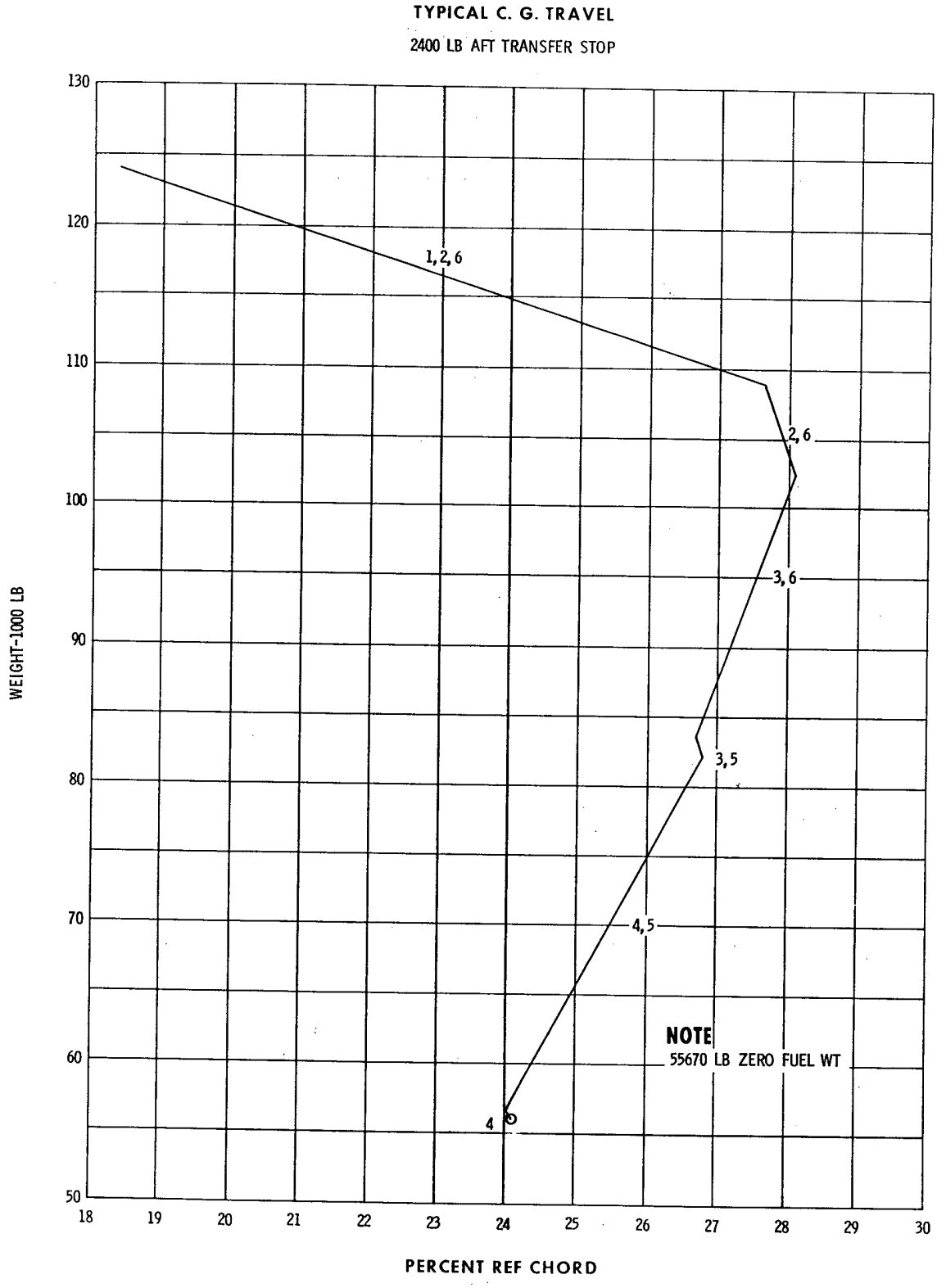

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Figure 7-4 (Sheet 3 of 3)

mum aft transfer rate is approximately 250 lbs per minute. If space is available in tank 6 such as for a ground takeoff after a non-afterburning period, the transfer rate is approximately 320 lb per minute. These rates are based on the present .649 size orifice.

JET PUMP SYSTEM

A system of six jet pumps is installed. These transfer residual fuel from tanks which are almost empty to tanks whose boost pumps are operating. Jet pumps scavenge tanks 1, 2, 3, 5 and 6. Fuel from tank 1 is scavenged by the jet pump in tank 2. Boost pump 3-1 operates the jet pump which scavenge tank 2. Boost pump 4-4 operates the jet pump to scavenge tank 3. Boost pump 4-3 operates the jet pump to scavenge tank 5 and tank pumps 5-1 and 5-2 operate 2 jet pumps to scavenge tank 6. Jet pump usage is entirely automatic and requires no attention by the pilot. A tube from the boost pump outlet to the jet pump expands a bellows which opens a valve connecting a suction tube from the previous sequenced tank to the low pressure section of a venturi. When a boost pump is not running, the bellows in its associated jet pump contracts and closes the suction tube between the tanks.

TANK 4 ULLAGE SYSTEM

Through action of bypass and relief valves, excess cooling loop and engine fuel hydraulic system fuel not burned by the engine, or hot fuel not accepted by the fuel control, (smart valve) may be returned to tank 4. If tank 4 is close to being full, a dual float switch activates pump 4-1 to furnish tank 4 fuel to the fuel manifold and create an ullage space in tank 4. This same float switch also turns off pump 2-1. When pump 4-1 is running pump 2-1 can not run. A second back up float switch controls pump 4-2 and prevents pump 6-1 from operating when pump 4-2 is running. The operation of the tank 4 ullage system is automatic and the cockpit fuel pump lights will not indicate when tank pumps 4-1 and 4-2 are operating. However, the fuel quantity indicator may show a drop in tank 4 fuel.

NOTE

The float switches are wired in series so that if one switch should stick closed pumps 4-1 and 4-2 will not keep running and so cause a premature depletion of tank 4 fuel.

FUEL TANK EMPTY LIGHT SEQUENCING

When tanks 1, 2 or 6 are empty the yellow EMPTY lights illuminate in the pushbutton switches. The empty lights for each tank will also illuminate for tank 3, 5 and 4 if normal sequence has been used. However, tanks 3, 5, and 4 do not always show an empty light if fuel has been used out of the normal sequence.

Tank 6 must be nearly empty before tank 5 empty light will illuminate. Tank 2 must be nearly empty before the tank 3 light will illuminate, and tank 5 must be nearly empty before the tank 4 empty light will illuminate. Tank 4 has a low warning light which operates independently of the tank empty light sequencing at the 5000 lb level. The individual tank quantities can also be checked if out of sequence fuel usage is suspected.

IN-FLIGHT REFUELING

In flight, all tanks can refuel simultaneously at invidivudal rates which vary from 550 ppm (tank 1) to approximately 1150 ppm (aft tank). The initial transfer rate if all tanks have space to accept fuel is approximately 5000 ppm with normal tanker nozzle pressure. The rate decreases as individual tanks are

filled, becoming 1500 to 550 ppm as the last tanks are topped off. Engine fuel requirements during refueling increase as the tanks fill, ranging from approximately 270 to 400 ppm total.

FUEL MANAGEMENT PRIOR TO REFUELING

Up to 4000 pounds of fuel should be transferred to tank 1 prior to making a refueling contact. The transfer improves the unaugmented pitch stability of the aircraft by moving its center of gravity forward. With normal SAS operation, there is no marked change in handling characteristics.

In some cases a tanker rendezvous may be made after a high speed run with tank 4 full or almost full, and fuel remaining in tank 5. Normal forward transfer would empty tank 5 first. Tank 4 only forward transfer is more desirable in this case to make the maximum amount of space available in that tank for cool fuel from the tanker. This improves the fuel heat sink capability. This also speeds up the refueling operation. Hot fuel transferred from tank 4 is consumed from tank 1 when its pumps start. With both generators functioning normally, the air refueling procedure may be accomplished without any fuel management action except that failure to make a Tank 4 XFR Only before an air refueling will affect the temperature of the fuel in tank 4 after the air refueling is completed.

FUEL MANAGEMENT DURING REFUELING

During refueling, the engines are supplied by normal pump sequencing. Tank 4 pumps, or any other pumps, will remain on if they have been turned on by manual sequencing. With the forward transfer switch off, tank 1 pumps will continue to supply both manifolds as long as fuel remains in that tank. With the forward transfer switch on, tank 1 pumps are made inoperative unless tank 1 is selected manually or tank 4 reaches 800 lbs. If not selected manually, tank 4 will be shut off when tanks 3 and 5 receive fuel and the start tank 4 float switches in the bottom of those tanks are opened.

SUBSONIC CRUISE FUEL MANAGEMENT

The aircraft fuel system sequencing was designed to optimize the aircraft c.g. at normal cruise. The recommended c.g. for subsonic flight is between 19% and 25% as stated in Section V.

For subsonic cruise the following procedure will keep the CG within the recommended limits for subsonic flight.

At 57,000 lbs fuel remaining or after takeoff if initial load is less than 57,000 lbs, turn forward transfer switch ON. Leave forward transfer switch ON until before landing check or when starting acceleration if final portion of flight is supersonic.

FLIGHT CONTROL SYSTEM

Do not move the control stick during engine start. The inboard and outboard elevons may not deflect simultaneously or equally when powered by one hydraulic system if pressure is less than 1500 psi. This is due to unequal friction in the inboard and outboard sets of elevon actuators. A preloaded spring in the control pushrod mechanism can move from its detent position as a result of unequal elevon movement. Restoration of normal hydraulic pressure should cause the elevons to resume normal symmetry and restore the spring to its detented position. However, an inspection is required to ascertain that the spring has reset properly.

STABILITY AUGMENTATION SYSTEM

Pitch Axis Characteristics Due to Lagged Pitch Rate Switching

SAS Lagged Pitch Rate switching may cause transient load factors to develop when climbing or descending through 50,000 feet. This is a normal SAS characteristic which results from the design of the SAS pitch rate damping circuits.

Signals from the SAS pitch gyros always go to a straight-through circuit that varies the pitch rate gain (damping response rate) with pitot differential pressure. In addition to this path, the signals go through a lagged pitch rate circuit that changes the pitch rate gain when above 50,000 ft. altitude. In a descent, the lagged pitch rate term is switched out at 50,000 ft., but this does not instantly remove the existing command. The signal that existed prior to switching drops instantly to a level equal to 12/13 of its value for the higher altitude. The remainder of the signal decays exponetially to zero with a time constant of 13 seconds.

These two pitch rate gains are summed prior to introduction into the servo amplifiers. Therefore, as the aircraft descends toward 50,000 ft. in a turn, the SAS is supplying an input to the pitch transfer valves as a function of aircraft bank angle, Mach number, altitude, and pitch rate, causing the elevon surfaces to be deflected from the position commanded by stick position and trim setting as long as there is an aircraft pitch rate. The nose up pitch rate causes the SAS to oppose pilot control and/or trim action by interposing a down elevon deflection increment.

When the aircraft passes through 50,000 ft. altitude while descending, the lagged pitch rate term is switched out of the circuit, causing the pitch rate gain to reduce to that of the straight through circuit. Response to control stick positioning becomes more positive, SAS opposition to the pilot induced pitch rate is reduced, and the elevons are automatically repositioned to a new angle which is governed by the lesser SAS gain. The aircraft responds to this surface change by exhibiting a bump in the nose up pitch direction. Repositioning of the control stick and/or retrimming is necessary, with the amount of change being a function of pitch rate desired before and after the transition. The reverse action is prevalent if the aircraft is in an ascending turn.

During transitions through 50,000 ft. with no pitch rate, i. e., straight line climb or descent, the gain will switch at 50,000 feet with no resulting aircraft movement.

BRAKE SYSTEM OPERATION

To stop an airplane, the kinetic energy must be absorbed by aerodynamic drag, braking action and rolling friction. The variable relationship of these factors is modified by the landing or aborted takeoff roll distance, speed at the beginning of deceleration and weight. Rolling friction, although of considerable effect, is neglected in the following discussion. Aerodynamic braking is composed of drag effects of the airplanes surfaces and the drag chute. The most effective airplane surfaces are the wing and elevons.

Braking action is limited by three factors; braking friction available between the tires and the runway, methods of brake application and the kinetic energy limits of the brakes. Rated brake capability is shown in figure 5-8. Braking friction available depends on runway conditions, weight, and positive or negative aerodynamic lift conditions. Other considerations affecting stopping capability are tire hydroplaning effects, efficiency of anti-skid devices and pilot technique. Techniques must be varied depending on conditions existing at the time. Speed at start of deceleration will be dependent on touchdown speed during landings and time required to deploy the chute and apply brakes. Aborted takeoff speed will depend on the abort decision point and speed increase during the period for pilot reaction. Weight factors will differ depending on normal or emergency landings or aborted takeoffs. Stopping techniques and/or procedures must also be varied depending on deployment or non-deployment of drag chute, runway length, weather conditions and tire capability.

Drag chute failure procedures in Section III are mainly intended for landing weight conditions although the procedures are somewhat applicable to aborted takeoff weights also. The following braking technique discussion is mainly applicable to heavy weight aborted takeoffs.

Braking On Dry Runways - Anti-Skid On

Energize the brakes smoothly with moderate to heavy pressure with the nosewheel on the runway for dry runway conditions. It is unlikely that the anti-skid system will actuate on dry runways at weights over 120,000 pounds. At lighter weights, it is possible to cause momentary wheel spindown and, if this occurs, the center tires are more susceptible to blowout.

Pilot judgement regarding braking technique must be used after drag chute deployment. Brake pressure may be relaxed if a relatively low speed can be attained after a short run with ample distance remaining. However, if distance is critical or a long run would result, maximum use of brakes must be continued until the stop is assured. This requires hard and continuous brake pressure.

NOTE

Hard braking may result in brake seizure after stopping, increasing time to clear the runway. If possible, keep the aircraft moving at slow speed until clear of the runway. Taxiing at low speed to clear a runway is permitted with all tires failed on a main gear. The massive tire bead tends to protect the wheels for a short distance at heavy weight.

Long runs at heavy weights may result in blown tires due to sidewall failures. Failure of one tire will usually overload the remaining tires on that side and probably cause successive failures. Therefore, sufficient brake pressure should be maintained during and after chute deployment to minimize stop distance. This reduces heat build-up in the tires which is characteristic of extended roll-outs at heavy weight. If

tire failure is known or suspected, maintain enough brake pressure to prevent wheel spin-up and, possibly, wheel and/or tire disintegration at high rotational speeds.

NOTE

- With a dry runway, do not use up elevon as a method of increasing braking force because of the additional risk of tire fatigue failure. A faster stop is possible with the rolling stock intact.

- If tires blow with either wet or dry conditions, increased brake pressure on that side is required to maintain braking force with the remaining tires.

- Rated brake energy capacities and associated maximum braking speeds may be disregarded during aborted takeoffs. It is considered better to use the brakes at high speed, as tire failure may occur if the roll is extended by delayed braking.

Braking on Wet Runways

Energize the brakes smoothly with light to moderate pressure and the nosewheel on the runway for wet or slippery runway conditions. If the drag chute does not deploy, select NORMAL (or ALT STEER & BRAKE if the left engine has failed), and then shut down a failed engine, or shutdown the right engine if there has been no engine failure, in order to reduce thrust and increase braking effectiveness. Also use moderate up elevons so as to provide as much drag as posssible without lifting the nosewheel. The increased gear load may cause tire failure at heavy weight; however, tire failure may be acceptable since the tires will not necessarily disintegrate. Braking deceleration available is nearly the same for braked tire rolling and blown tire locked conditions with a wet surface. Locked wheel skids of up to 7000 feet have left the wheels undamaged during wet runway testing.

Unless hydroplaning is encountered, good nosewheel and rudder steering characteristics can be expected and have been demonstrated during stops on wet runways with and without the drag chute, with all main gear tires blown and wheels locked, and with one engine shut down.

Hydroplaning in various forms is a limiting factor with wet runway conditions and, although nosewheel and rudder steering remain effective, wheel braking force is nill until the tires can make contact with the runway. The aircraft tends to follow a trajectory and will drift with a crosswind. Except for the extended stop distance involved, skids across or into dry runway areas are the chief hazard of wet runway stops. The wheels tend to lock-up and cause blown tires while sliding on a wet surface. Dry areas tend to destroy the tires due to increased friction or wheel spin-up. This allows the wheels to make runway contact and may ultimately destroy the wheels and then the brake assemblies. Even so, the aircraft can probably survive on the landing gear struts so long as it remains on the main runway, or on a hard surface overrun where there is a smooth transition from runway to overrun.

ALL WEATHER OPERATION

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INTRODUCTION

Except for repetition necessary for emphasis or continuity of thought, this section contains only those procedures which differ from or are in addition to the normal procedures supplied in Section II.

INSTRUMENT FLIGHT PROCEDURES

These aircraft handle well during all phases of instrument flight when operated in accordance with procedures specified in the following paragraphs. As with all high performance jet aircraft, constant attention to flight instruments is required. Normal jet instrument techniques are satisfactory for operation during instrument conditions. Navigational aids include an Inertial Navigation System, TACAN, ILS and ADF. IFF is also installed, as are the directional and ranging features of the ARC/50 radio.

The ships pitot static system is the primary speed and altitude reference during takeoff, penetration, approach and landing. Speeds given here are knots indicated airspeed (KIAS). Equivalent airspeeds (KEAS) and

altitude information from the air data computer system (TDI instrument) can be used; however, TDI response may not be as rapid as the ship system indications during transient airspeed situations.

The stall warning indication is referenced to pitot total pressure and to the attitude probe in the Rosemount pitot-static boom. It is independent of pitot-static pressures sensed by the ship and air data computer systems to that extent. Pitot heat should be sufficient to keep both the pitot head and the attitude probe operating during icing conditions.

NOTE

Keep pitot heat on during all subsonic instrument flight operations.

BEFORE INSTRUMENT TAKEOFF

After aligning the aircraft with the centerline of the runway, check synchronization of the FRS compass, check the INS mode selector in FRS position, and set the attitude indicator so that the miniature airplane is level with the horizon line. The BDHI No. 1 needle selector switch is placed in the TACAN position to display TACAN bearing information on the No. 1 needle of the BDHI.

NOTE

The FRS compass will be used for heading reference during all takeoffs and instrument departures.

INSTRUMENT TAKEOFF

Maximum thrust will be used for instrument takeoffs, using procedures identical to those contained in Section II. The following procedures supplement those given in Section II:

a. Rotation - Begin at computed rotation speed. Apply smooth, constant back pressure to establish an indication of + 10 to + 12 degrees on the attitude indicator in about five seconds. The aircraft will fly off the runway at normal airspeeds.

b. Maintain 10 to 12 degree pitch attitude indication while accelerating to desired climb speed. The altimeter and vertical velocity indicator should show a definite climb indication before retracting the landing gear. Care must be exercised to insure that a positive rate of climb is maintained during acceleration to climb speed in order to prevent the aircraft from settling back to the runway surface.

NOTE

Initial indications of the altimeter and vertical speed indicator may be that of a slight descent.

c. Landing gear lever - UP when definitely airborne.

d. Throttles - Minimum afterburning after gear up is indicated. Military thrust may be set as 300 KIAS is approached when a Military power climb is used for instrument departure.

NOTE

Use Indicated Airspeed during takeoff and climb until proper climb speed schedule is reached on the TDI.

INSTRUMENT CLIMB

Instrument climbs using the normal airspeed and afterburner schedules can be made safely. It may be desirable to maintain maximum afterburning after takeoff at heavy weights, but allowances must be made for the more rapid acceleration and steeper than normal climb attitude. It is highly recommended that the normal afterburning schedule be used after takeoff. This minimizes the possibility of exceeding the desired climb speed schedule. It also provides more time for EGT control if this is required. Maximum thrust may be resumed if desired after stabilizing at the proper climb speed.

NOTE

- Reduce climb speed if rough air is encountered as described in Operation in Turbulence, this section.
- The TDI and ship system pitot-static flight instruments should be cross checked periodically during instrument flight to confirm proper operation.

Restrict all turning maneuvers to 30° maximum bank angle during low altitude instrument flight.

MILITARY THRUST CLIMBS

The optimum VFR Military thrust schedule is suitable for instrument climbs to intermediate altitudes. As soon as the climb schedule is intercepted, the TDI becomes the primary pitch control instrument for the remainder of the climb.

INSTRUMENT CRUISING FLIGHT

Establish cruising airspeed at the desired altitude and retrim the aircraft. After Instrument Departure Instructions have been accomplished, the BDHI may be switched to display INS navigation information as required for mission completion. Readjust the horizon bar on the attitude indicator to indicate level flight attitude when the aircraft is in level flight at cruising airspeed. These aircraft have excellent handling characteristics throughout their normal flight speed range if properly trimmed and flown by reference to the flight instruments.

NOTE

Below Flight Level 180, the altimeter must be set to station pressure and used to maintain assigned altitude.

TURNS

A constant 30° angle of bank may be used for all turns except rate turns when required or desired.

STEEP TURNS

Any angle of bank exceeding 30° is considered a steep turn. The aircraft is easily controlled on instruments in banks up to 60°; however, due to structural load restrictions, bank angles in excess of 45° should be avoided.

HOLDING

Holding patterns and descents between holding levels should be flown at 275 KIAS at altitudes from 35,000 ft to 20,000 feet. (KEAS ranges between 260 and 270 knots at these altitudes.) Approximately 6200 rpm will be required. At normal weights, average fuel flow while turning varies from approximately 5500 pph per engine at the higher altitudes to approximately 6500 pph

JET PENETRATION AND TACAN APPROACH (Typical)

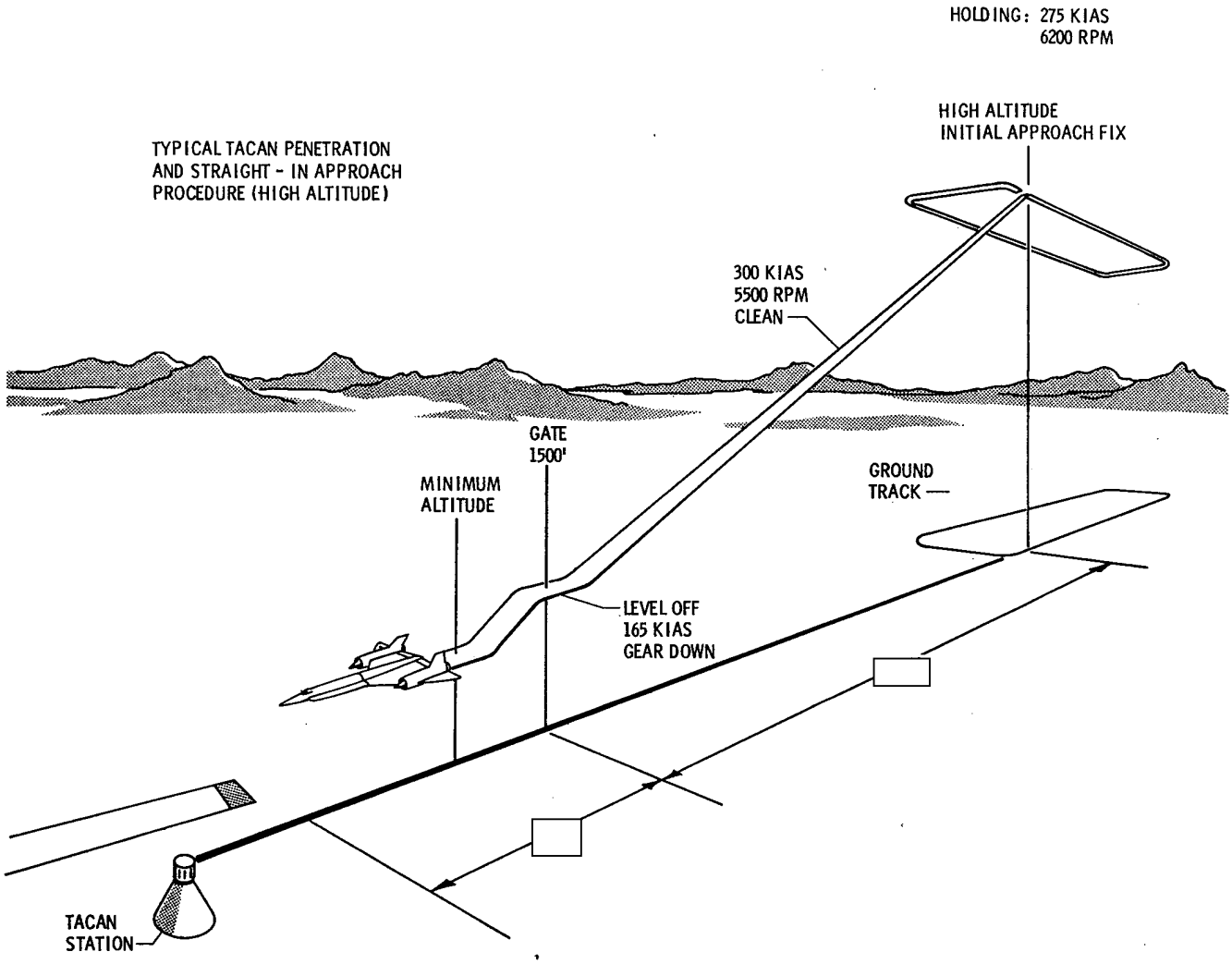


Figure 9-1

at 20,000 feet. The rate decreases about 500 pph per engine during straight legs. Somewhat lower airspeeds can be used, if desired, if there is little or no turbulence. To descend between holding levels, reduce power until 500 to 1000 feet above the desired altitude. Refer to Appendix for loiter performance.

NOTE

- The INS mode selector must be placed in the FRS position prior to initial station passage and entry into the holding pattern.
- Check the FRS compass for synchronization and that the BDHI No. 1 needle selector switch is in the desired TACAN or ADF position.
- When the BDHI No. 1 needle selector switch is placed in the TACAN or ADF position and the INS mode selector switch is placed in the FRS position, the No. 1 needle of the BDHI will display magnetic bearing to the selected ADF or TACAN station provided the AN/ARC-50 function switch is not in the ADF position. For the same conditions except with INS mode selected, true heading will be displayed.

JET PENETRATION

The ships pitot-static instruments are the primary flight instruments during a penetration procedure descent. These penetrations are flown at 300 KIAS with power set at 5500 rpm. Initial rate of descent will be 3000 to 4000 fpm. Approximately 4000 pph per engine fuel flow can be expected for normal weights when starting from 20,000 feet. The initial rpm should be maintained and fuel flow allowed to increase as altitude is lost.

NOTE

Engine speeds below 5000 rpm should be avoided to prevent cycling of the engine start bleed valves. TACAN will be inoperative if left engine rpm is below approximately 4500.

The landing gear may be used for additional drag during the penetration if desired, but should be extended no earlier than middle station passage and no later than the turn to final approach when making a procedure turn to final approach heading. In a normal teardrop penetration or straight in approach the landing gear should be extended prior to the final approach gate. At normal approach gross weights, maintain 230 to 250 KIAS after level off through the turn to final approach. Total fuel flow increases to approximately 13,000 lb/hr with the gear down. Final approach speeds are identical to those for normal traffic patterns and landings and will be adjusted for existing gross weight. For a single engine approach the gear should not be extended until final approach is initiated. Minimum approach speed is 200 KIAS for a single engine approach.

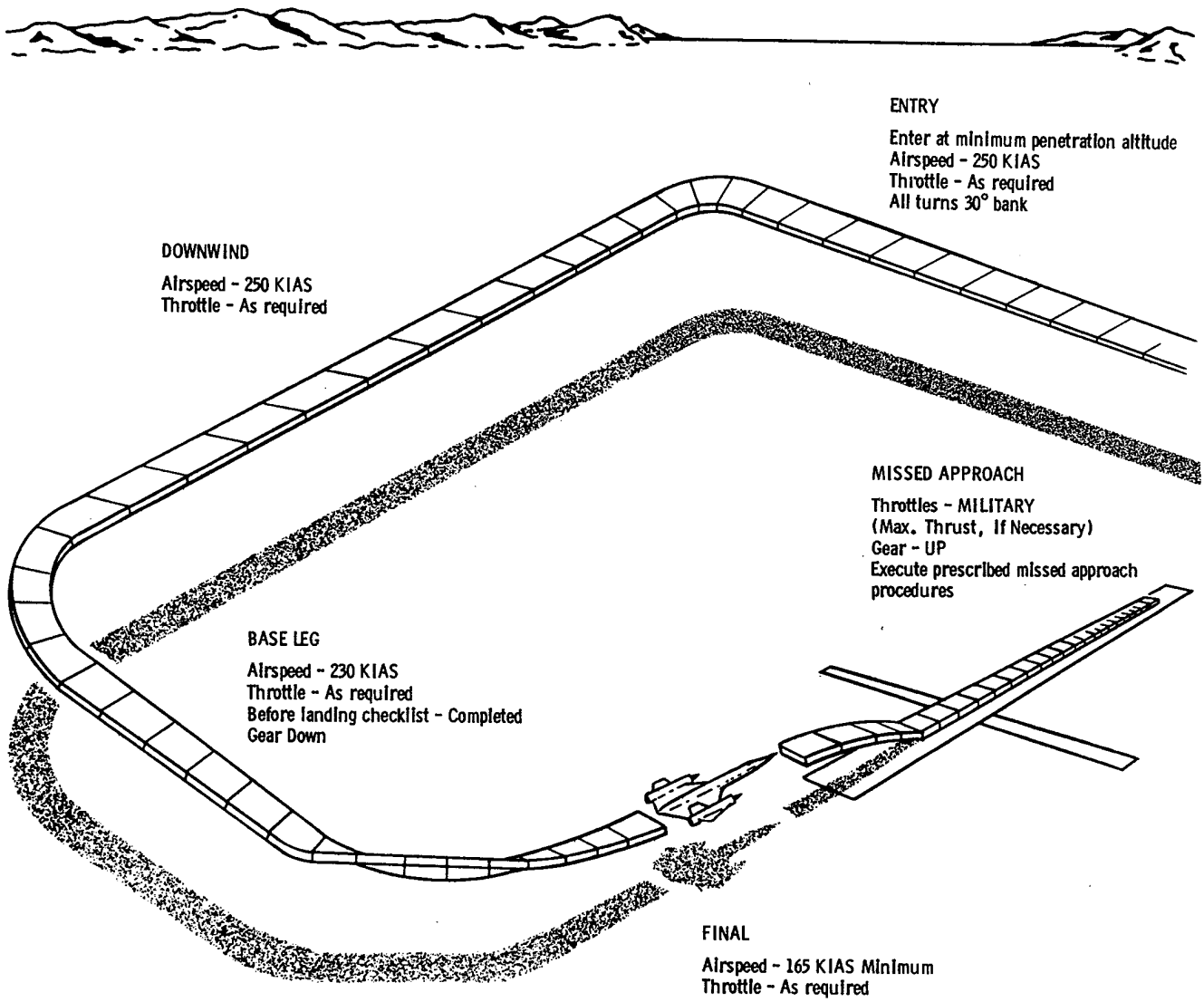
NOTE

Fuel required for a typical teardrop penetration is from 1000 to 1700 pounds.

INSTRUMENT APPROACHES

These aircraft are equipped to make either TACAN, ILS or ADF approaches. Precision Approach Radar (PAR) approaches may also be made. When flown as recommended, aircraft control response is good at all times. The downwind or outbound portions of all approaches are flown at 250 KIAS with the landing gear down. The base

RADAR APPROACH PAR/ASR



NOTE
Increase final approach speed 1 knot for each 1000 lbs. over 5000 lbs. of fuel remaining

9-7-65
F200-53(b)

Figure 9-2

leg or procedure turn portions are flown 230 KIAS. The minimum final approach speed is 165 KIAS and should be increased by one knot for each 1000 pounds of fuel remaining over 5000 pounds under normal operating conditions. With one engine inoperative, hold gear extension until the final turn is completed and maintain a minimum final approach speed of 200 KIAS.

NOTE

- When the left engine has failed, the landing gear must be extended using the Emergency Landing Gear Extension procedure. The pilot should be aware of the time required and of the other aircraft systems which are affected by loss of the left engine.
- Altimeter position error corrections are small at instrument approach speeds and may be neglected.
- Use the rain remover and windshield defog and deice systems as needed.

MISSED APPROACH AND GO-AROUND

Apply Military thrust as soon as it is determined that a go-around is necessary. Use afterburning or Maximum thrust if necessary. Raise the landing gear only after a climb has been established, and climb to the missed approach altitude at 250 KIAS. When positive rate of climb has been established adjust power as necessary to maintain 250 KIAS and approximately 1000 to 2000 foot per minute climb. In the event a single engine missed approach is necessary, follow the single engine go-around procedures in Section III and observe the single engine minimum control speed.

NOTE

Fuel required for a missed approach and GCA is approximately 3000 pounds. A VFR closed pattern go-around requires approximately 1000 pounds.

ICE AND RAIN

Detailed information on flight through icing conditions is not conclusive at this time. Flight to and from terminal areas where heavy icing conditions and/or heavy rain are present is undesirable. Extended flight in any known icing conditions is prohibited. If icing conditions or heavy rain at near freezing conditions is encountered in flight, the engines must be examined for damage during post flight inspection.

WINDSHIELD ICING

Without hot air deicing, forward visibility through the windshield is unsatisfactory under all icing conditions at penetration and approach speeds. Ice buildup occurs very rapidly and dissipates very slowly, particularly with heavy build-up, even after descent to lower, warmer altitudes. Ice will build up on the spikes at penetration and approach speeds and enter the engine as it breaks off upon descent to warmer altitudes. Engine damage due to ice ingestion is not normally severe enough to cause engine shutdown and can be minimized by reducing

STRUCTURAL CAPABILITY IN GUSTS

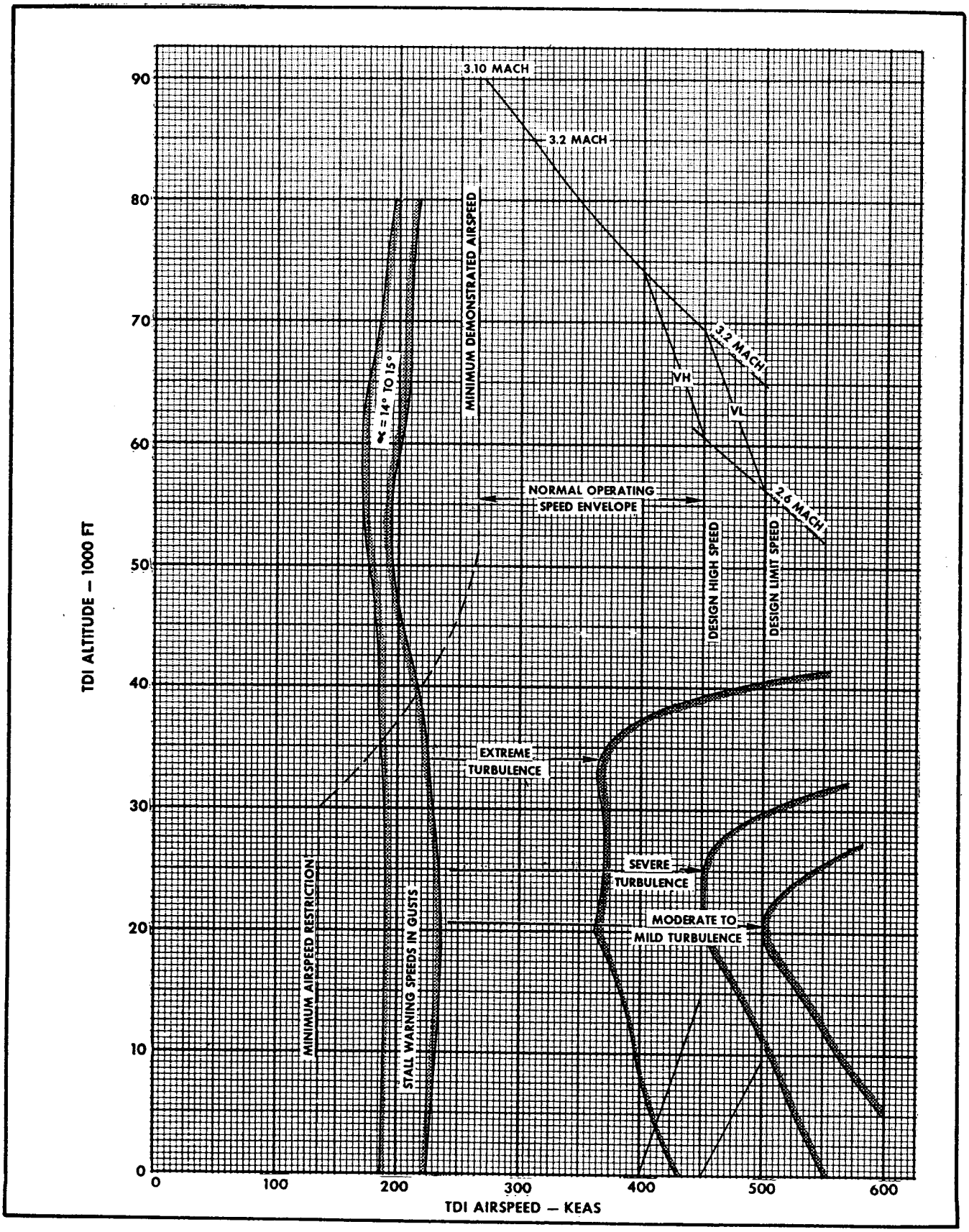


Figure 9-3

rpm. Hot air flow on the windshield is satisfactory for de-icing and inhibiting ice build-up if used prior to the time that icing conditions are encountered. If windshield icing is anticipated or encountered:

1. Windshield deicer switch - R, or L & R, as required.

FLIGHT IN RAIN

In rain, forward visibility is obscured by a water film which extends over almost all of the windshield area. Use of the rain remover liquid during light and moderate rain conditions improves visibility to a usable condition at approach speeds. Visibility is momentarily obscured as the liquid is ap-aplied, then the windshield clears and beads of water form which stream across the glass. Rain remover application is needed at ten to fifteen second intervals for best effectiveness. The hot air deicer should not be used in light to moderate rain, as the hot air by itself does not clear the windshield, and the rain remover liquid is apparently blown away before it can become effective. The rain remover system is not effective with very heavy rain conditions, and, although hot air deicing provides very slight improvement, visibility remains obscured.

NOTE

Reduce speed below 250 KIAS before applying rain remover fluid.

CAUTION

Do not apply rain repellent on a dry windshield. Prolonged obscuration may result.

1. Rain removal button - PUSH.

NOTE

Momentary cloudiness will occur.

2. Repeat as required when visibility deteriorates.

HIGH HUMIDITY CONDITIONS

If fog emanates from cockpit overhead distribution ducts:

1. Q-Bay temp control - INCREASE as required.

If condensation forms on inner or outer glass:

2. Windshield defog switch - INCREASE as required.

3. Windshield deicer switch - ON R, or L & R, as required.

TURBULENCE AND THUNDERSTORMS

Flight should not be scheduled through areas where extreme or severe turbulence is forecast. In the event that such conditions are encountered however, airspeed should be maintained between 250 and 350 KEAS as a general rule. Refer to the Structural Capability In Gusts chart, figure 9-3.

OPERATION IN TURBULENCE

Gust conditions are defined in terms of "extreme", "severe", and "moderate to mild" conditions. (Refer USAF AWSM 55-8, 15 June 1965). Aircraft structural capabilities in turbulence air do not penalize nor-

mal operating procedures except when below 40,000 feet. In the event of extreme turbulence below 40,000 feet, airspeed should be maintained between 250 and 350 KEAS. Figure 9-3 shows that the aircraft can be operated safely in severe turbulence at the design speed unless in the altitude range between 20,000 and 25,000 feet. A speed reduction to 400 KEAS should be accomplished by reducing power if severe turbulence is encountered while operating at high speed in this area. (The normal Mach 0.9 climb speed in this area is below 400 KEAS.) Normal descent speed, 300 KEAS, approaches the optimum path for rough air penetration.

Transonic Acceleration in Turbulence

The probability of encountering unforecasted severe or extreme turbulence in clear air is relatively small. However, if there is a reasonable possibility that this may occur during the transonic acceleration phase, modify the normal climb procedure. After reaching supersonic conditions, climb at 375 to 400 KEAS instead of 450 KEAS while below 30,000 feet. Increase the climb speed above this altitude so as to reach normal climb speed between 35,000 and 40,000 feet. Be prepared to reduce airspeed to 375 KEAS if severe turbulence is encountered below 40,000 feet.

Jet Penetration and Landing Approach

Normal penetration and approach speeds are compatible with rough air penetration schedules. However, the normal turn to final approach speed may be increased from 230 KIAS to 250 KIAS in order to avoid the possibility of maneuvering difficulty during this phase. Standard rough air penetration techniques apply to this aircraft.

COLD AND HOT WEATHER PROCEDURES

Detailed cold or hot weather procedures are not available. The pilot should always be aware of the effects of non-standard temperatures on takeoff and landing distances and minimum single engine control speeds. The pilot should also be aware of the effects of wet, icy, and slush covered runways on takeoff and landing distances and on ground handling characteristics. Refer to Section V for cold weather Oil Temperature operating limits.

NIGHT FLYING

Detailed specific night flying procedures are not required; however, the normal precaution of memorizing the positions of switches located in dim or unlighted locations should be accomplished. Lower fire warning light covers to reduce glare in event of illumination.

PERFORMANCE DATA

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PART I

INTRODUCTION

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DATA BASIS

Engines

The performance charts are based on test data with YJ and/or YJ-1 engines.

Fuel and Fuel Density

These data are applicable to aircraft fueled with PWA 523E with PS 67A additive. Deviations from the nominal fuel density of 6.45 pounds per gallon have negligible effect on performance as long as actual aircraft gross weight and fuel load are known. However, with all tanks filled to capacity, the maximum fuel load changes 1060 pounds for each 0.1 pound per gallon change in fuel density. This effect on operational capabilities must be considered.

AIRSPEED SYSTEMS

Airspeed, altitude, and Mach number are available from the ship system instruments and from the triple display indicator (TDI). The ship normal and alternate systems supply conventional altimeter and airspeed Mach number indicators. The TDI provides digital values for equivalent airspeed (KEAS), corrected pressure altitude, and true Mach number. The differences between indicated airspeed (KIAS) and KEAS are a function of speed, altitude, and ship system position error. A comparison of KEAS from the triple display indicator and KIAS from the ship's normal system instruments is shown by Figure A1-3. For example: at 400 KEAS, the normal ship system will indicate 420 KIAS at 20,000 feet indicated pressure altitude and 475 KIAS at 50,000 feet indicated altitude. Other combinations of indicated altitude and KIAS can be determined from Figure A1-3 for use in the event of TDI failure.

POSITION ERROR CORRECTIONS

Triple Display Indicator

The Triple Display Indicator of the Air Data computer system is the primary instrument for climb and for all operations above FL 180. Its digital indications are almost completely compensated for position

error and compressibility effects; however, the TDI airspeed lags during takeoff. IAS from the normal ship system should be used until climb speed is attained. The ship system should also be used for pattern operation and landing, although the TDI follows these speed and altitude changes without excessive lag.

Normal Ship System

Figures A1-1 and A1-2 show position error corrections for the altimeter and airspeed-Mach number indicators when the normal (Rosemount pitot static) system is selected. Corrections for operation at subsonic speeds were obtained by calibrations in flight and during ground runs. Corrections provided for supersonic speeds were obtained from wind tunnel results. Standard corrections for compressibility effects must be applied (subtracted) after the position error corrections are made in order to obtain equivalent airspeeds. The compressibility correction is supplied on Figure A1-5. The position error and compressiblity corrections have been combined on Figure A1-3 in order to allow a direct comparison between KIAS and KEAS instruments.

Alternate Ship System

The alternate system senses pitot static pressure by means of a flush static port and total head tube located under the right hand chine. When the alternate system is selected, these pressures operate the ship system altimeter and airspeed-Mach number indicator. The position error corrections are provided by Figure A1-4.

COMPRESSIBILITY CORRECTIONS

Standard corrections for compressibility effects on KIAS are provided by Figure A1-5. These correction should be subtracted from KIAS after the airspeed position error corrections are made in order to obtain KEAS.

TRUE MACH NUMBER VS EQUIVALENT AIRSPEED

Figure A1-6 shows the relationship between true Mach number, pressure altitude, and equivalent airspeed, based on a γ of 1.4, the standard atmospheric parameter.

MACH-AIRSPEED-TEMPERATURE CHART

Ambient air temperature and true airspeed can be obtained from the TDI Mach and CIT gage as shown on the Mach-Airspeed-Temperature Chart, figure A1-7. For example, at a TDI Mach of 3.05 and CIT of 300°C, the ambient air temperature is 72°C and the true airspeed is 1680 knots (28 nmi/minute). The affect of adiabatic compression and temperature rise on atmospheric characteristics has been included by using a variable γ parameter.

STANDARD ATMOSPHERE TABLE

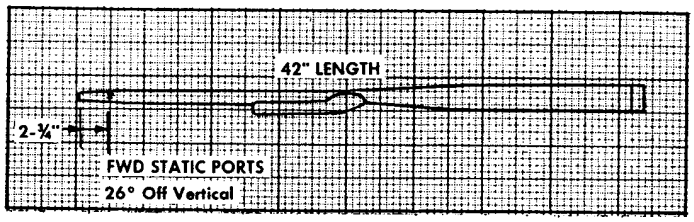
The 1956 ARDC standard atmospheric table, Figure A1-8, provides reference temperature, pressure, air density, and sonic speed information which may be of assistance in over-all flight planning.

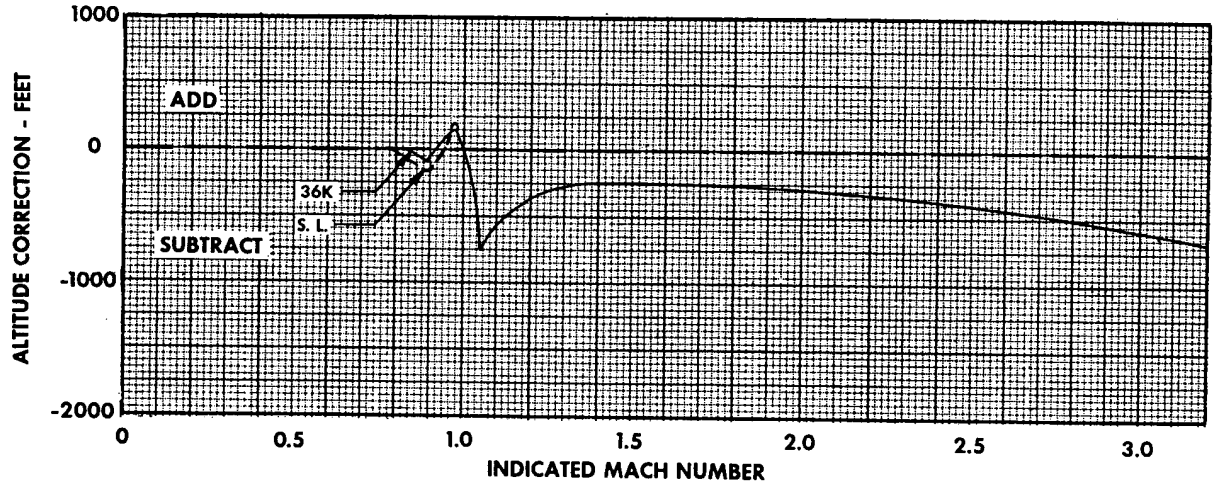
STANDARD UNITS CONVERSION

The standard units conversion chart, Figure A1-9, provides a means for direct conversion of temperature, distance, and speed between English and metric units.

POSITION ERROR CORRECTIONS VS MACH NO. – NORMAL (SHIP) SYSTEM

PITOT - STATIC SYSTEM ALTITUDE AND AIRSPEED INSTRUMENTS
ROSEMOUNT PITOT STATIC TYPE NO. 855





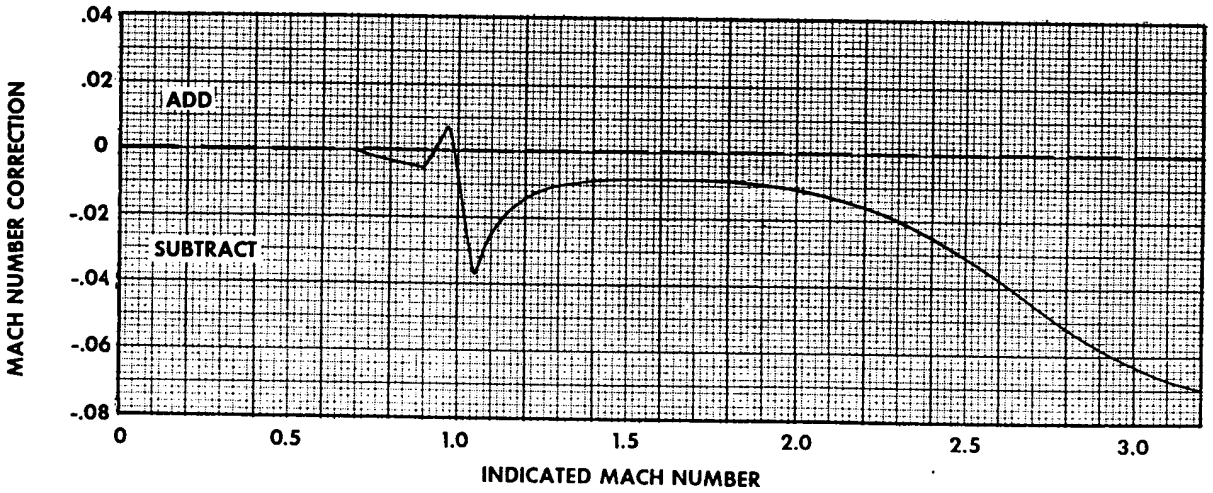


Figure A1-1

POSITION ERROR CORRECTIONS VS IAS — NORMAL (SHIP) SYSTEM

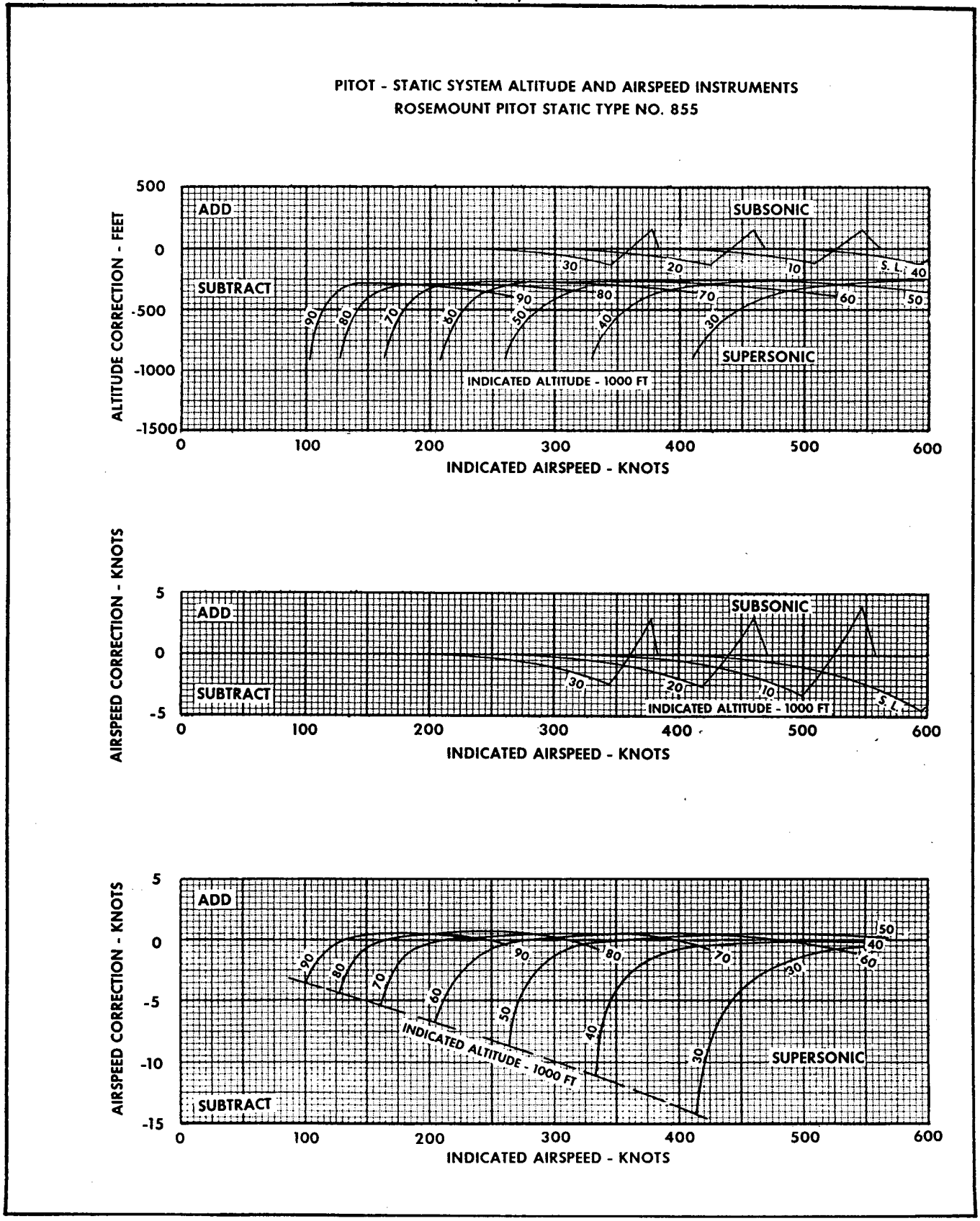


Figure A1-2

APPROXIMATE DIFFERENCES BETWEEN IAS AND EAS INDICATIONS

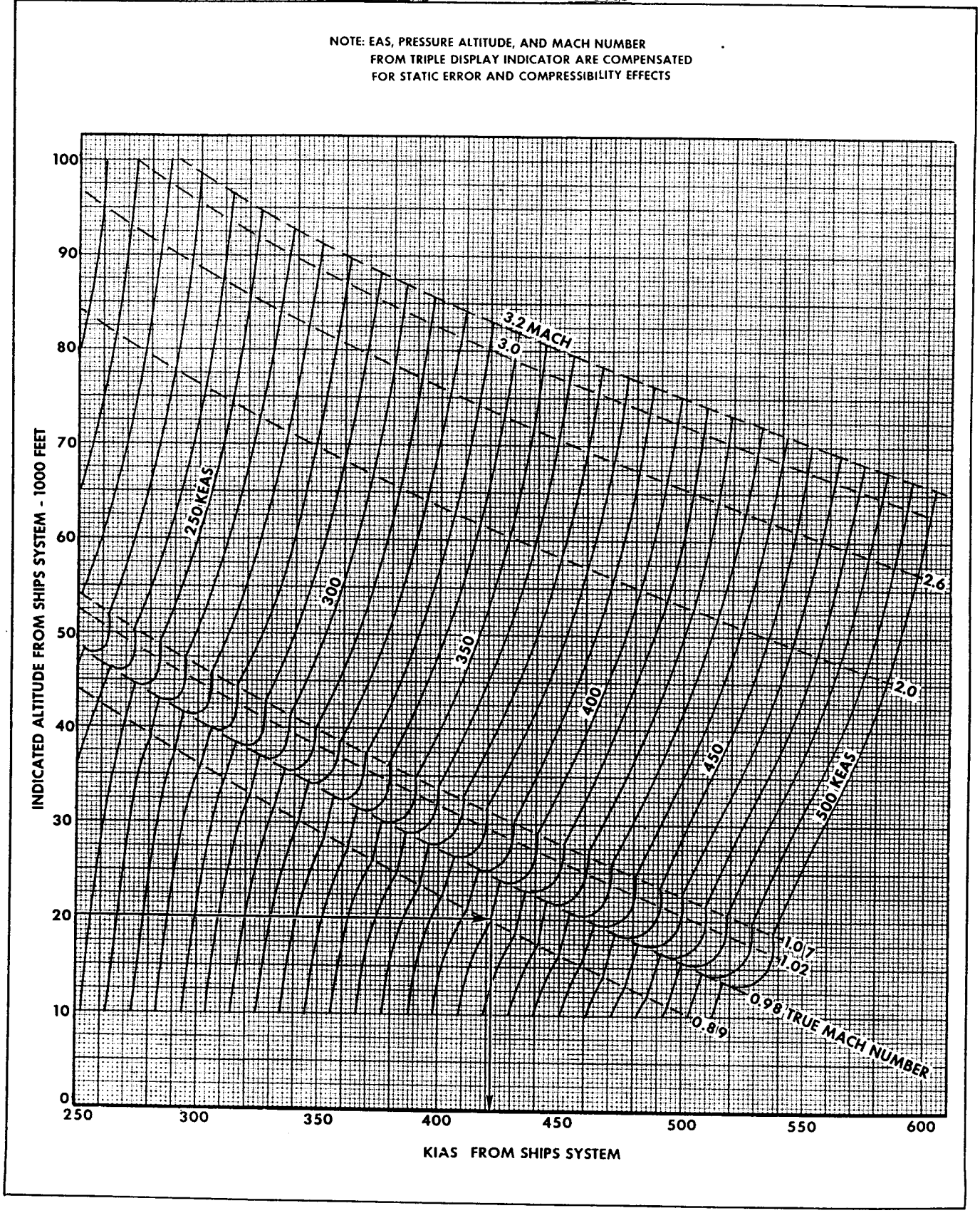
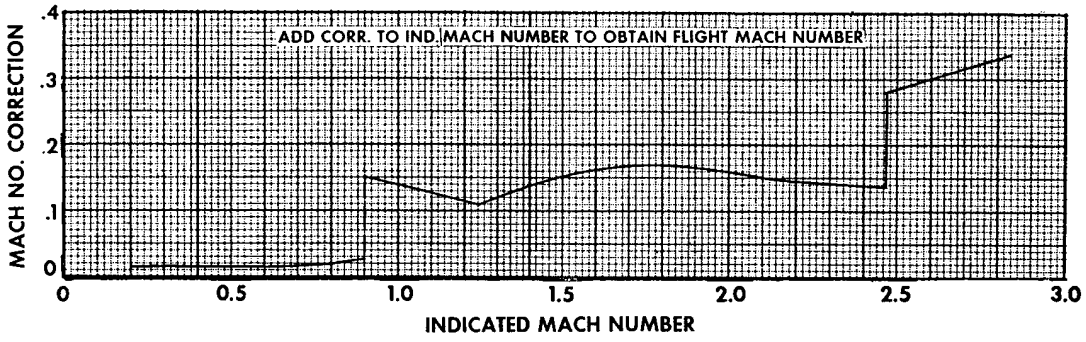
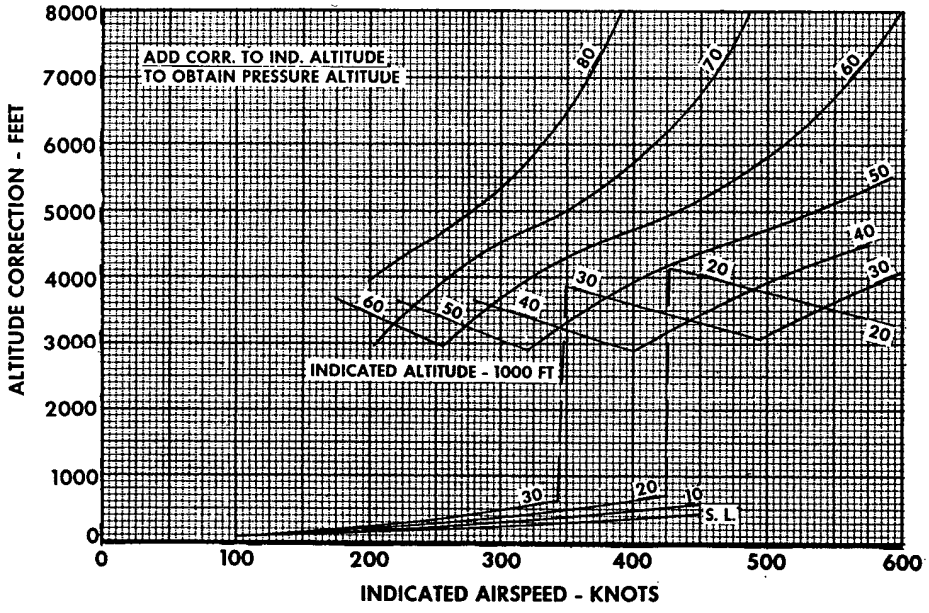


Figure A1-3

POSITION ERROR CORRECTIONS-ALTERNATE PITOT STATIC SYSTEM

ALTERNATE (FLIGHT RECORDER) AIRSPEED SYSTEM
CHINE PITOT AND FLUSH STATIC





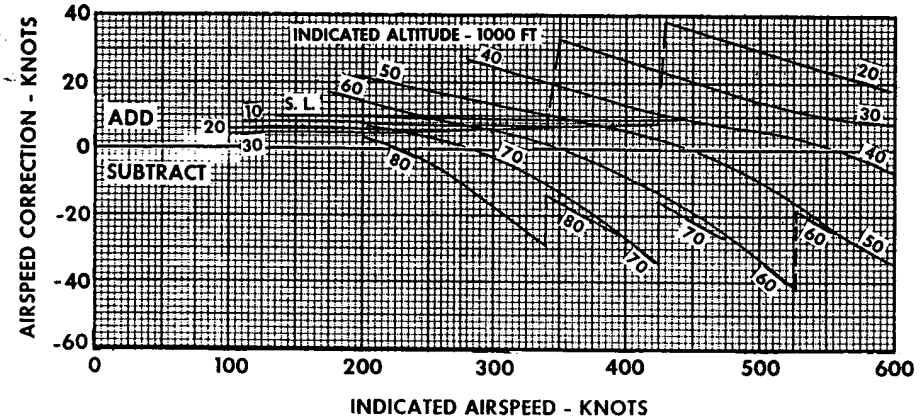


Figure A1-4

AIRSPEED COMPRESSIBILITY CORRECTION CHART

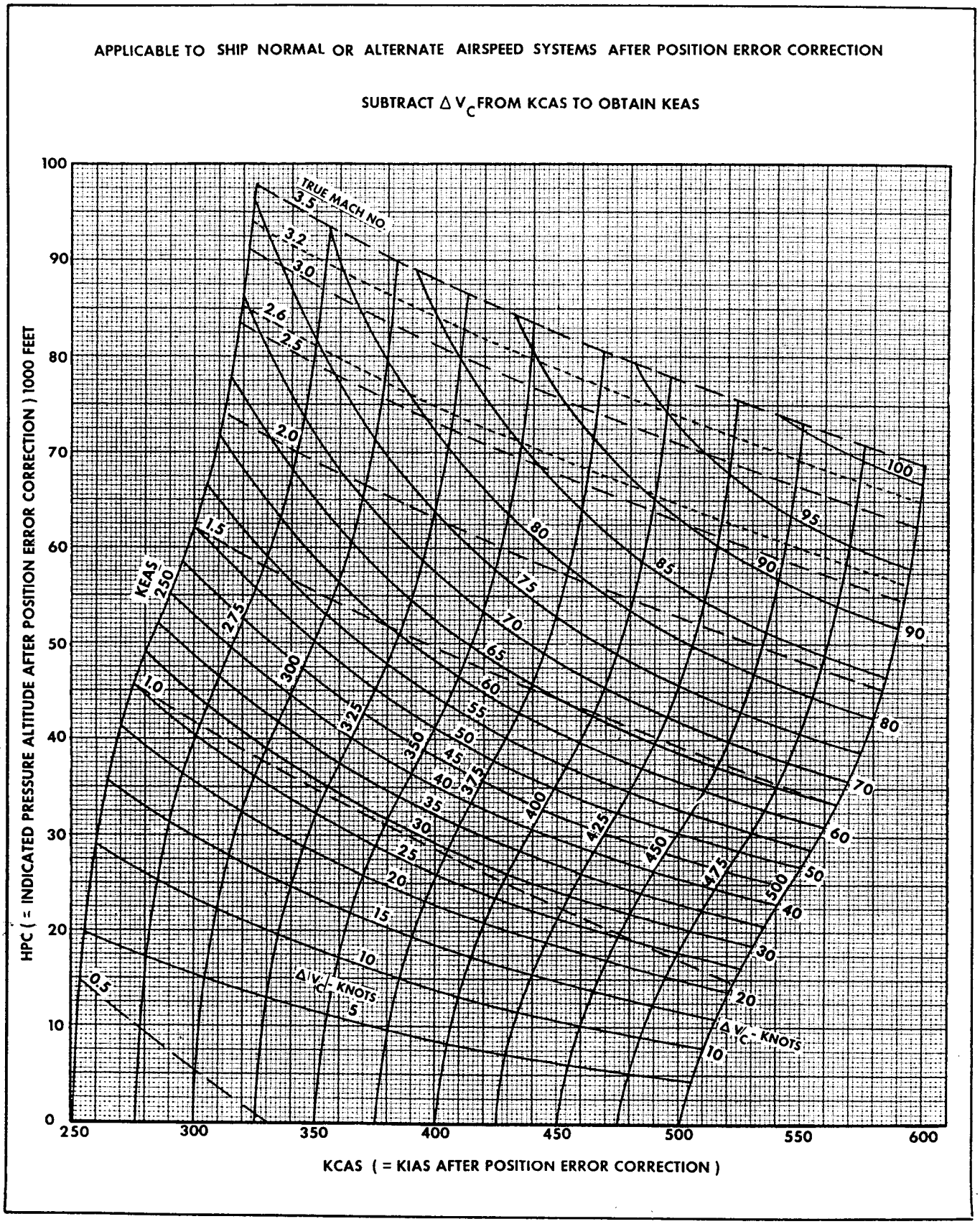

APPLICABLE TO SHIP NORMAL OR ALTERNATE AIRSPEED SYSTEMS AFTER POSITION ERROR CORRECTION
SUBTRACT Δ V_C FROM KCAS TO OBTAIN KEAS
HPC (= INDICATED PRESSURE ALTITUDE AFTER POSITION ERROR CORRECTION) 1000 FEET
KCAS (= KIAS AFTER POSITION ERROR CORRECTION)
TRUE MACH NO.
KEAS
Δ V_C - KNOTS
0 10 20 30 40 50 60 70 80 90 100
250 300 350 400 450 500 550 600

Figure A1-5

TRUE MACH NUMBER VS EQUIVALENT AIRSPEED

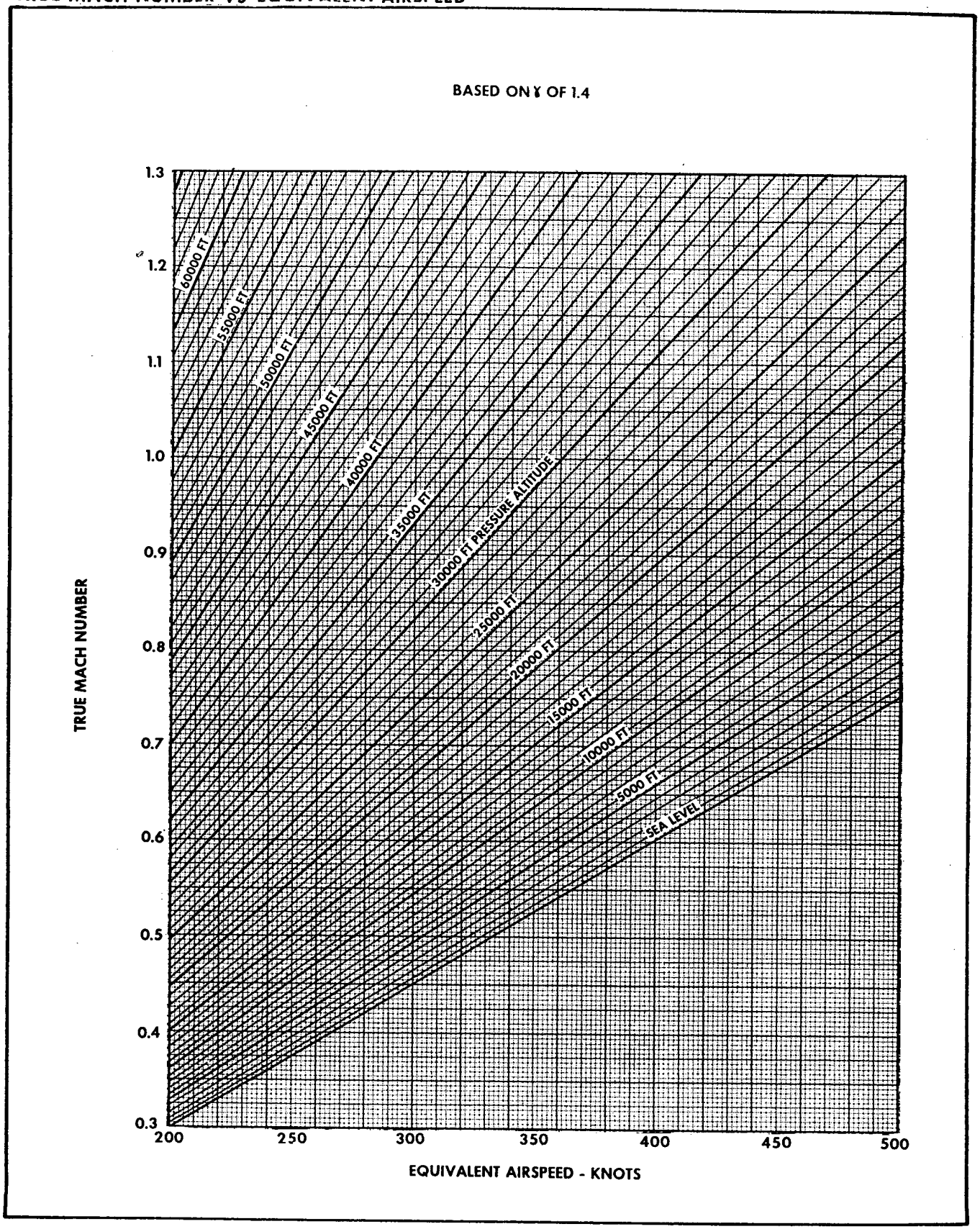


Figure A1-6
(Sheet 1 of 3)

TRUE MACH NUMBER VS EQUIVALENT AIRSPEED

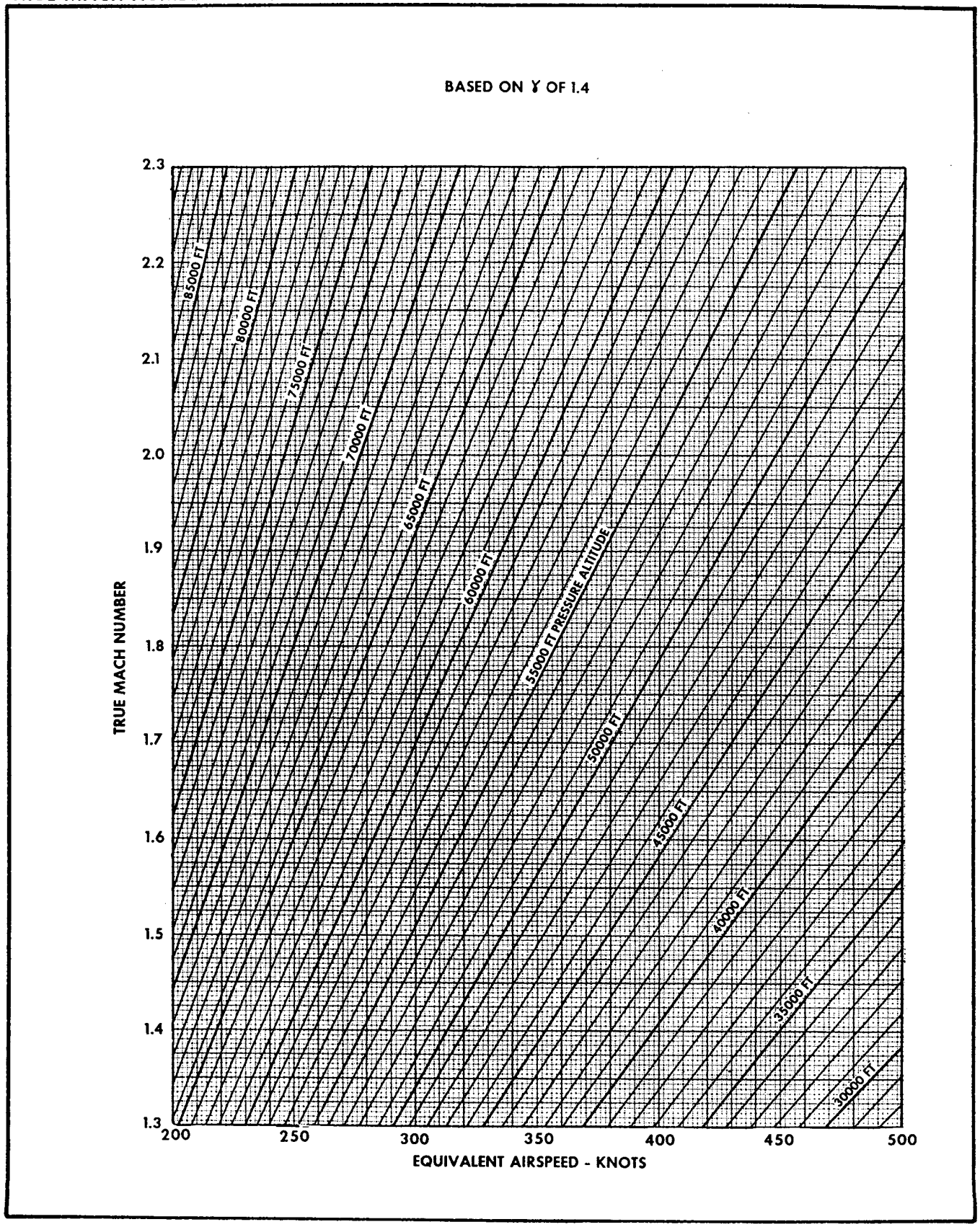


Figure A1-6
(Sheet 2 of 3)

TRUE MACH NUMBER VS EQUIVALENT AIRSPEED

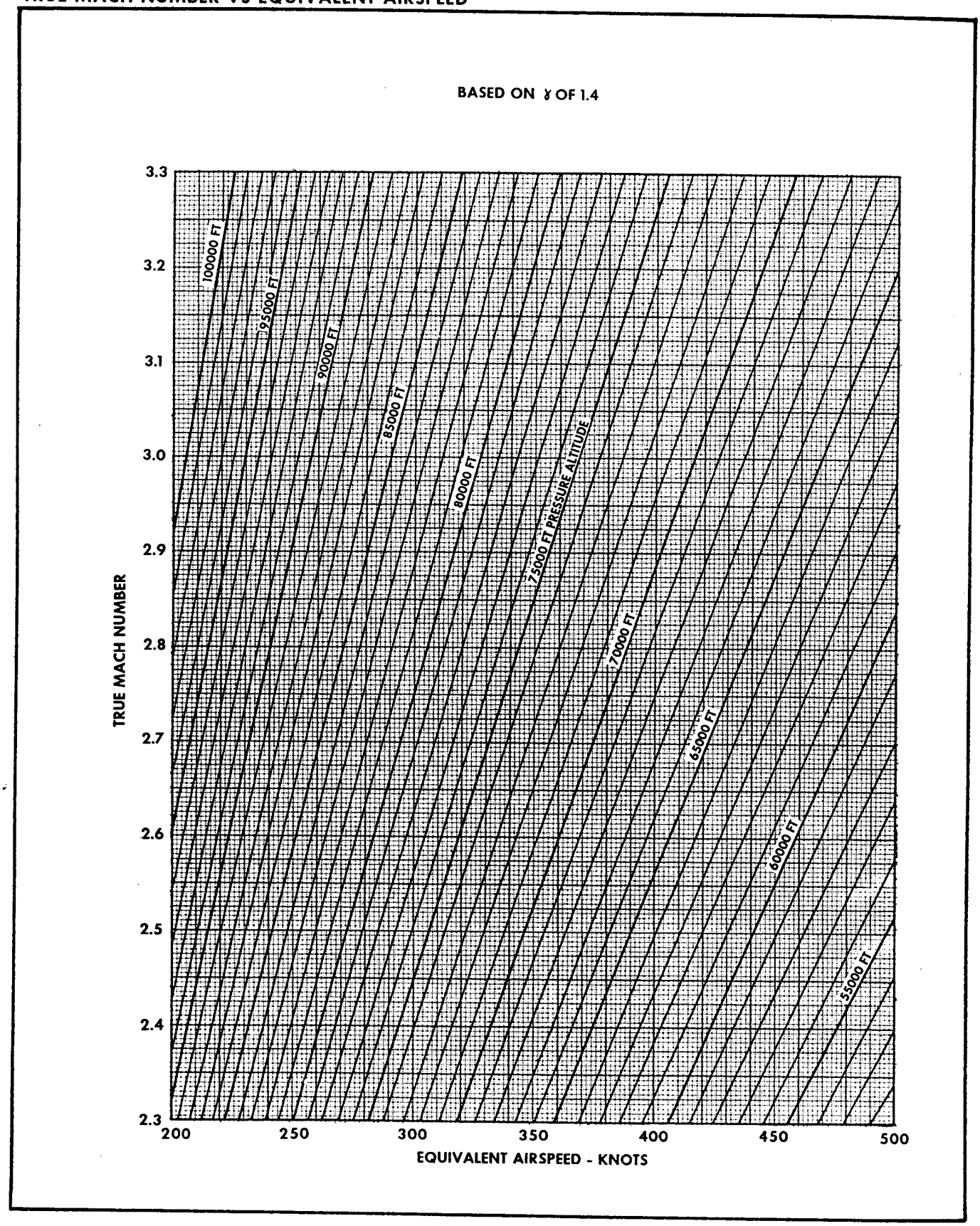


Figure A1-6
(Sheet 3 of 3)

MACH-AIRSPEED-TEMPERATURE CONVERSION CHART

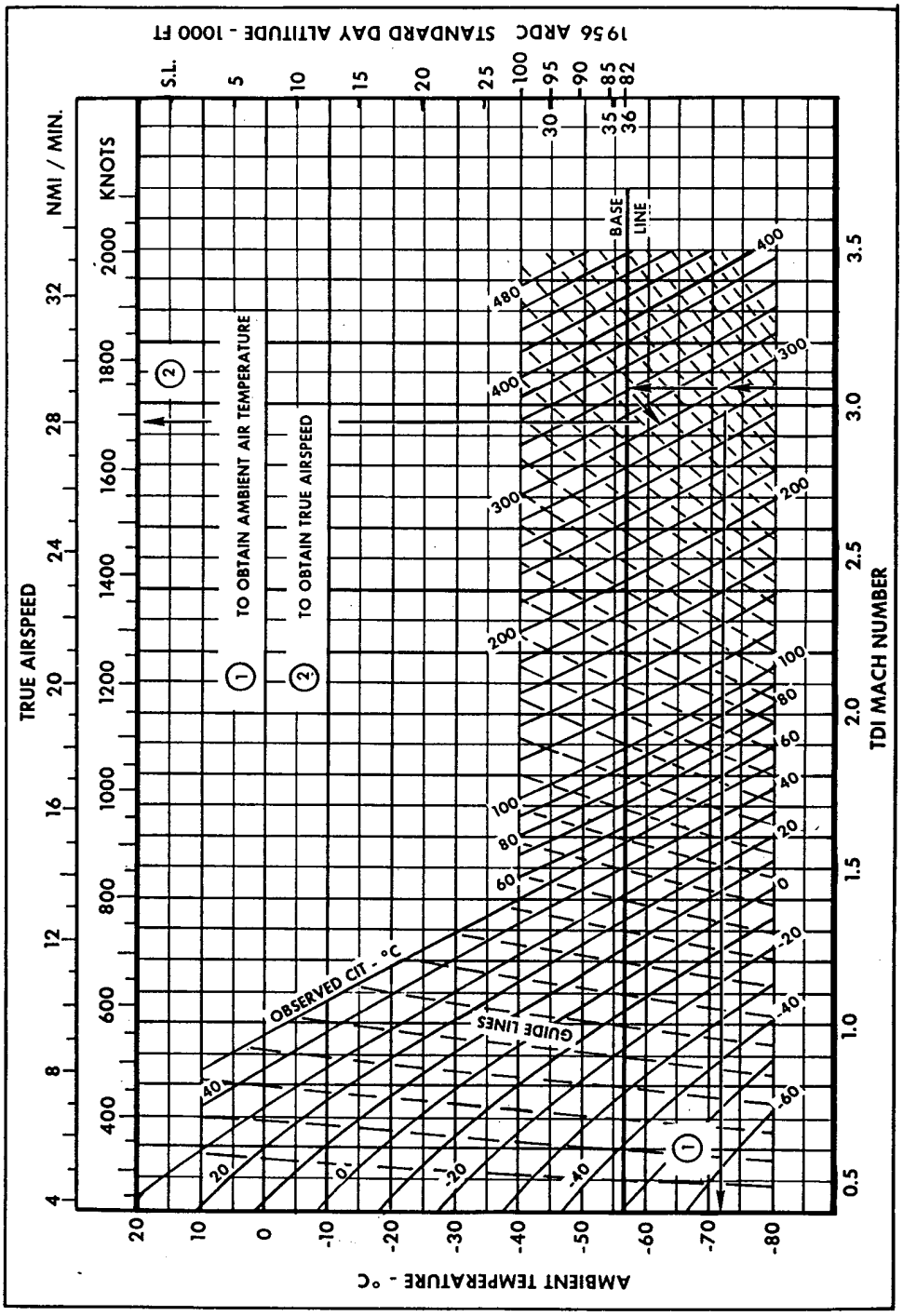


Figure A1-7

STANDARD ATMOSPHERE TABLE

ARDC MODEL ATMOSPHERE – 1956

Alt ft	Temp. t °F	Temp. t °C	Press. P in. Hg	Press. P lb/ft²	$\frac{\rho}{\rho_o} = \sigma$	$\sqrt{\frac{\rho}{\rho_o}}$	$\frac{P}{P_o} = \delta$	$\frac{T}{T_o} = \theta$	$\sqrt{\frac{T}{T_o}}$	$\frac{P}{P_o}\sqrt{\frac{T}{T_o}}$	c ft/sec	Alt ft
0	59.0	15.0	29.92	2116	1.000	1.000	1.000	1.000	1.000	1.000	1117	0
1000	55.4	13.0	28.86	2041	.9711	.9854	.9644	.9931	.9965	.9610	1113	1000
2000	51.9	11.0	27.82	1968	.9428	.9710	.9298	.9862	.9931	.9234	1109	2000
3000	48.3	9.1	26.82	1897	.9151	.9566	.8962	.9794	.9896	.8869	1105	3000
4000	44.7	7.1	25.84	1828	.8881	.9424	.8637	.9725	.9862	.8518	1101	4000
5000	41.2	5.1	24.90	1761	.8617	.9283	.8320	.9656	.9826	.8175	1098	5000
6000	37.6	3.1	23.98	1696	.8359	.9143	.8014	.9587	.9791	.7847	1094	6000
7000	34.0	+1.1	23.09	1633	.8106	.9003	.7716	.9519	.9757	.7529	1090	7000
8000	30.5	-0.8	22.22	1572	.7860	.8866	.7428	.9450	.9721	.7221	1086	8000
9000	26.9	-2.8	21.39	1513	.7620	.8729	.7148	.9381	.9686	.6924	1082	9000
10000	23.3	-4.8	20.58	1455	.7385	.8594	.6877	.9312	.9650	.6636	1078	10000
11000	19.8	-6.8	19.79	1400	.7156	.8459	.6614	.9244	.9615	.6360	1074	11000
12000	16.2	-8.8	19.03	1346	.6932	.8326	.6360	.9175	.9579	.6092	1070	12000
13000	12.6	-10.8	18.29	1294	.6713	.8193	.6113	.9106	.9543	.5834	1066	13000
14000	9.1	-12.7	17.58	1243	.6500	.8062	.5875	.9037	.9506	.5585	1062	14000
15000	5.5	-14.7	16.89	1194	.6292	.7932	.5643	.8969	.9470	.5344	1058	15000
16000	+1.9	-16.7	16.22	1147	.6090	.7804	.5420	.8900	.9434	.5113	1054	16000
17000	-1.6	-18.7	15.57	1101	.5892	.7676	.5203	.8831	.9397	.4889	1050	17000
18000	-5.2	-20.7	14.94	1057	.5699	.7549	.4994	.8762	.9361	.4675	1045	18000
19000	-8.8	-22.6	14.34	1014	.5511	.7424	.4791	.8694	.9324	.4467	1041	19000
20000	-12.3	-24.6	13.75	972.5	.5328	.7299	.4595	.8625	.9287	.4267	1037	20000
21000	-15.9	-26.6	13.18	932.4	.5150	.7176	.4406	.8556	.9250	.4076	1033	21000
22000	-19.5	-28.6	12.64	893.7	.4976	.7054	.4223	.8487	.9212	.3890	1029	22000
23000	-23.0	-30.6	12.11	856.3	.4806	.6933	.4046	.8419	.9176	.3713	1025	23000
24000	-26.6	-32.5	11.60	820.2	.4642	.6813	.3876	.8350	.9138	.3542	1021	24000
25000	-30.2	-34.5	11.10	785.3	.4481	.6694	.3711	.8281	.9100	.3377	1016	25000
26000	-33.7	-36.5	10.63	751.6	.4325	.6576	.3552	.8212	.9062	.3219	1012	26000
27000	-37.3	-38.5	10.17	719.1	.4173	.6460	.3398	.8144	.9024	.3066	1008	27000
28000	-40.9	-40.5	9.725	687.8	.4025	.6344	.3250	.8075	.8986	.2920	1004	28000
29000	-44.4	-42.5	9.297	657.6	.3881	.6230	.3107	.8006	.8948	.2780	999.4	29000
30000	-48.0	-44.4	8.885	628.4	.3741	.6116	.2970	.7937	.8909	.2646	995.1	30000
31000	-51.6	-46.4	8.488	600.3	.3605	.6004	.2837	.7869	.8871	.2517	990.7	31000
32000	-55.1	-48.4	8.106	573.3	.3473	.5893	.2709	.7800	.8832	.2393	986.4	32000
33000	-58.7	-50.4	7.737	547.2	.3345	.5784	.2586	.7731	.8793	.2274	982.0	33000
34000	-62.2	-52.4	7.382	522.1	.3220	.5675	.2467	.7662	.8753	.2159	977.7	34000
35000	-65.8	-54.3	7.041	498.0	.3099	.5568	.2353	.7594	.8714	.2050	973.3	35000
36089	-69.7	-56.5	6.683	472.7	.2971	.5450	.2234	.7519	.8671	.1937	968.5	36089
37000	-69.7	-56.5	6.397	452.4	.2844	.5333	.2138	.7519	.8671	.1854	968.5	37000
38000	-69.7	-56.5	6.097	431.2	.2710	.5206	.2038	.7519	.8671	.1767	968.5	38000
39000	-69.7	-56.5	5.811	411.0	.2583	.5082	.1942	.7519	.8671	.1684	968.5	39000
40000	-69.7	-56.5	5.538	391.7	.2462	.4962	.1851	.7519	.8671	.1605	968.5	40000
41000	-69.7	-56.5	5.278	373.3	.2346	.4844	.1764	.7519	.8671	.1530	968.5	41000
42000	-69.7	-56.5	5.030	355.8	.2236	.4729	.1681	.7519	.8671	.1458	968.5	42000
43000	-69.7	-56.5	4.794	339.1	.2131	.4616	.1602	.7519	.8671	.1389	968.5	43000
44000	-69.7	-56.5	4.569	323.2	.2031	.4507	.1527	.7519	.8671	.1324	968.5	44000
45000	-69.7	-56.5	4.355	308.0	.1936	.4400	.1455	.7519	.8671	.1262	968.5	45000
46000	-69.7	-56.5	4.151	293.6	.1845	.4295	.1387	.7519	.8671	.1203	968.5	46000
47000	-69.7	-56.5	3.956	279.8	.1758	.4193	.1322	.7519	.8671	.1146	968.5	47000
48000	-69.7	-56.5	3.770	266.7	.1676	.4094	.1260	.7519	.8671	.1093	968.5	48000
49000	-69.7	-56.5	3.593	254.1	.1597	.3996	.1201	.7519	.8671	.1041	968.5	49000
50000	-69.7	-56.5	3.425	242.2	.1522	.3901	.1145	.7519	.8671	.09928	968.5	50000
51000	-69.7	-56.5	3.264	230.8	.1451	.3809	.1091	.7519	.8671	.09460	968.5	51000
52000	-69.7	-56.5	3.111	220.0	.1383	.3719	.1040	.7519	.8671	.09018	968.5	52000
53000	-69.7	-56.5	2.965	209.7	.1318	.3630	.09909	.7519	.8671	.08592	968.5	53000
54000	-69.7	-56.5	2.826	199.8	.1256	.3544	.09444	.7519	.8671	.08189	968.5	54000
55000	-69.7	-56.5	2.693	190.5	.1197	.3460	.09001	.7519	.8671	.07805	968.5	55000
56000	-69.7	-56.5	2.567	181.5	.1141	.3378	.08578	.7519	.8671	.07438	968.5	56000
57000	-69.7	-56.5	2.446	173.0	.1087	.3297	.08176	.7519	.8671	.07089	968.5	57000
58000	-69.7	-56.5	2.331	164.9	.1036	.3219	.07792	.7519	.8671	.06756	968.5	58000
59000	-69.7	-56.5	2.222	157.2	.09877	.3143	.07426	.7519	.8671	.06439	968.5	59000
60000	-69.7	-56.5	2.118	149.8	.09414	.3068	.07078	.7519	.8671	.06137	968.5	60000
61000	-69.7	-56.5	2.018	142.8	.08972	.2995	.06746	.7519	.8671	.05849	968.5	61000
62000	-69.7	-56.5	1.924	136.1	.08551	.2924	.06429	.7519	.8671	.05575	968.5	62000
63000	-69.7	-56.5	1.833	129.7	.08150	.2855	.06127	.7519	.8671	.05313	968.5	63000
64000	-69.7	-56.5	1.747	123.6	.07767	.2787	.05840	.7519	.8671	.05064	968.5	64000
65000	-69.7	-56.5	1.665	117.8	.07403	.2721	.05566	.7519	.8671	.04826	968.5	65000
66000	-69.7	-56.5	1.587	112.3	.07055	.2656	.05306	.7519	.8671	.04600	968.5	66000
67000	-69.7	-56.5	1.513	107.0	.06724	.2593	.05056	.7519	.8671	.04384	968.5	67000
68000	-69.7	-56.5	1.442	102.0	.06409	.2532	.04819	.7519	.8671	.04179	968.5	68000
69000	-69.7	-56.5	1.374	97.19	.06108	.2471	.04592	.7519	.8671	.03982	968.5	69000
70000	-69.7	-56.5	1.310	92.63	.05821	.2413	.04377	.7519	.8671	.03795	968.5	70000

Figure A1-8
(Sheet 1 of 2)

STANDARD ATMOSPHERE TABLE

ARDC MODEL ATMOSPHERE – 1956

Alt ft	Temp. t °F	°C	Press. P in. Hg	lb/ft²	$\frac{\rho}{\rho_o}=\sigma$	$\sqrt{\frac{\rho}{\rho_o}}$	$\frac{P}{P_o}=\delta$	$\frac{T}{T_o}=\theta$	$\sqrt{\frac{T}{T_o}}$	$\frac{P}{P_o}\sqrt{\frac{T}{T_o}}$	c ft/sec	Alt ft
71000	−69.7	−56.5	1.248	88.28	.05548	.2355	.04172	.7519	.8671	.03618	968.5	71000
72000	−69.7	−56.5	1.190	84.14	.05288	.2300	.03976	.7519	.8671	.03448	968.5	72000
73000	−69.7	−56.5	1.134	80.19	.05040	.2245	.03789	.7519	.8671	.03285	968.5	73000
74000	−69.7	−56.5	1.081	76.43	.04803	.2192	.03611	.7519	.8671	.03131	968.5	74000
75000	−69.7	−56.5	1.030	72.84	.04578	.2140	.03442	.7519	.8671	.02985	968.5	75000
76000	−69.7	−56.5	.9815	69.42	.04363	.2089	.03280	.7519	.8671	.02844	968.5	76000
77000	−69.7	−56.5	.9355	66.16	.04158	.2039	.03127	.7519	.8671	.02711	968.5	77000
78000	−69.7	−56.5	.8916	63.06	.03963	.1991	.02980	.7519	.8671	.02584	968.5	78000
79000	−69.7	−56.5	.8497	60.10	.03777	.1943	.02840	.7519	.8671	.02463	968.5	79000
80000	−69.7	−56.5	.8099	57.28	.03600	.1897	.02707	.7519	.8671	.02347	968.5	80000
81000	−69.7	−56.5	.7718	54.59	.03431	.1852	.02580	.7519	.8671	.02237	968.5	81000
82021	−69.7	−56.5	.7349	51.98	.03267	.1807	.02456	.7519	.8671	.02130	968.5	82021
83000	−68.1	−55.6	.7012	49.59	.03104	.1762	.02343	.7550	.8689	.02036	970.5	83000
84000	−66.4	−54.7	.6685	47.28	.02947	.1717	.02234	.7582	.8607	.01923	972.5	84000
85000	−64.8	−53.8	.6374	45.08	.02798	.1673	.02130	.7613	.8725	.01858	974.5	85000
86000	−63.2	−52.9	.6079	43.00	.02658	.1630	.02032	.7645	.8744	.01777	976.6	86000
87000	−61.5	−51.9	.5799	41.02	.02525	.1589	.01938	.7677	.8762	.01698	978.6	87000
88000	−59.9	−51.1	.5533	39.13	.02399	.1549	.01849	.7708	.8780	.01623	980.6	88000
89000	−58.2	−50.1	.5280	37.45	.02280	.1510	.01765	.7740	.8798	.01553	982.6	89000
90000	−56.6	−49.2	.5040	35.65	.02167	.1472	.01684	.7772	.8816	.01485	984.6	90000
91000	−54.9	−48.3	.4811	34.03	.02061	.1436	.01608	.7804	.8834	.01421	986.6	91000
92000	−53.3	−47.4	.4594	32.49	.01960	.1400	.01535	.7835	.8852	.01359	988.6	92000
93000	−51.6	−46.4	.4387	31.03	.01864	.1365	.01466	.7867	.8870	.01300	990.6	93000
94000	−50.0	−45.6	.4191	29.64	.01773	.1332	.01401	.7899	.8888	.01245	992.6	94000
95000	−48.3	−44.6	.4004	28.32	.01687	.1299	.01338	.7931	.8906	.01192	994.6	95000
96000	−46.7	−43.7	.3826	27.06	.01606	.1267	.01279	.7962	.8923	.01141	996.6	96000
97000	−45.1	−42.8	.3656	25.86	.01529	.1236	.01222	.7994	.8941	.01093	998.6	97000
98000	−43.4	−41.9	.3495	24.72	.01455	.1206	.01168	.8026	.8959	.01046	1001	98000
99000	−41.8	−41.0	.3341	23.63	.01386	.1177	.01117	.8058	.8977	.01003	1003	99000
100000	−40.1	−40.1	.3195	22.60	.01320	.1149	.01068	.8089	.8994	.009606	1005	100000
110000	−23.7	−30.9	.2062	14.58	.008196	.09053	.006890	.8407	.9170	.006318	1024	110000
120000	−7.19	−21.8	.1352	9.561	.005179	.07197	.004518	.8724	.9340	.004220	1043	120000
130000	+9.27	−12.6	.09000	6.365	.003327	.05768	.003008	.9041	.9508	.002860	1062	130000
140000	25.7	−3.50	.06076	4.297	.002170	.04658	.002031	.9359	.9674	.001965	1081	140000
150000	42.2	+5.67	.04156	2.940	.001436	.03789	.001389	.9676	.9837	.001366	1099	150000
200000	−6.78	−21.5	.00621	0.440	.000238	.01542	.000208	.8732	.9345	.000194	1044	200000

ATMOSPHERIC STANDARDS

	English	Metric
Gravity	32.17405 ft/sec²	9.80665 m/sec²
Absolute zero	−459.688°F	−273.16°C
Standard Values at Sea Level		
Pressure	29.92 in. Hg	760 mm Hg
Pressure	2116 lb/ft²	10332 kg/m²
Temp	59°F	15°C
Abs temp	518.688°R	288.16°K
Specific wt $g\rho_o$	0.076475 lb/ft³	1.2250 kg/m³
Density	0.0023769 lb sec²/ft⁴	0.12492 kg sec²/m⁴
Standard Values at Altitude		
Isothermal alt H	36,089.2 ft	11,000 m
Isothermal temp	−69.7°F	−56.5°C

GENERAL PROPERTIES OF GASES

$Pv = RT$ or $P = \rho gRT$ or $PV = mRT$

Constant Volume $P_1/P_2 = T_1/T_2$

Constant Pressure $V_1/V_2 = T_1/T_2$

Constant Temperature $P_1/P_2 = V_2/V_1$

Reversible Adiabatic $\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^{\gamma}$

$$\frac{T_1}{T_2} = \left(\frac{V_2}{V_1}\right)^{\gamma-1} = \left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}}$$

Polytropic $P_1V_1^n = P_2V_2^n$

$$\frac{T_1}{T_2} = \left(\frac{V_1}{V_2}\right)^{1-n} = \left(\frac{P_1}{P_2}\right)^{\frac{n-1}{n}}$$

Figure A1-8
(Sheet 2 of 2)

STANDARD UNITS CONVERSION CHART

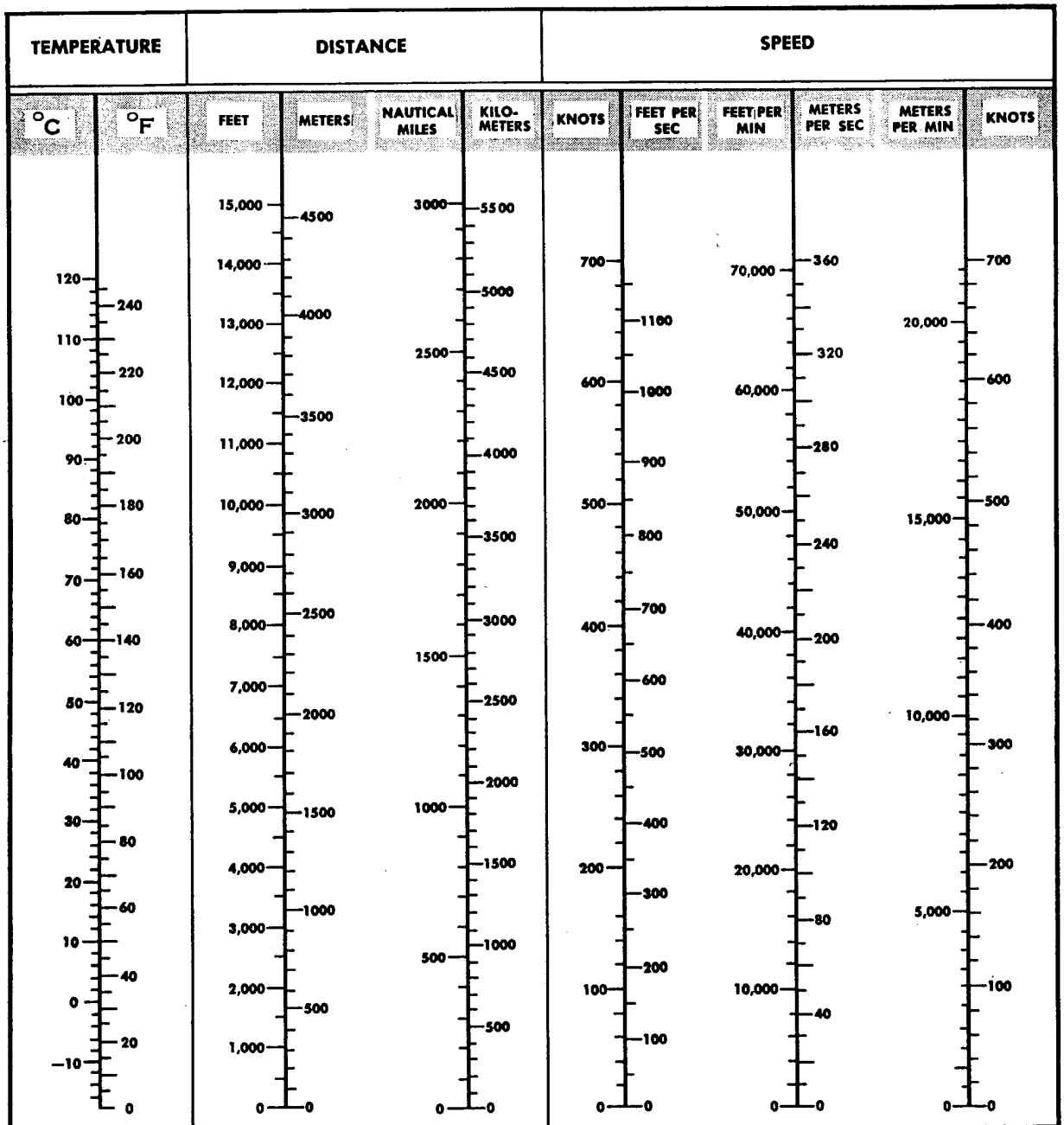


Figure A1-9

PART II

FIELD LENGTH REQUIREMENTS

Title	Figure No.
Normal Performance Takeoff	A2-1
Maximum Performance Takeoff	A2-2
Acceleration Check	A2-3
Refusal Speeds	
With Drag Chute, Dry Runway	A2-4
With Drag Chute, Wet Runway	A2-5
Without Drag Chute, Dry Runway	A2-6
Without Drag Chute, Wet Runway	A2-7
Maximum Weight For Single Engine Flight	
Gear Down - In Ground Effect	A2-8
Gear Up - In Ground Effect	A2-9
Gear Up - Out of Ground Effect	A2-10
Landing Speed Schedules	A2-11
Landing Dsitance - Normal Performance	
With Drag Chute, Dry Runway	A2-12
With Drag Chute, Wet Runway	A2-13
Without Drag Chute, Dry Runway	A2-14
Without Drag Chute, Wet Runway	A2-15
Landing Distance - Maximum Performance	
With Drag Chute, Dry Runway	A2-16
With Drag Chute, Wet Runway	A2-17
Without Drag Chute, Dry Runway	A2-18
Without Drag Chute, Wet Runway	A2-19

TAKEOFF

Takeoff performance data are supplied for two types of takeoff operations. One applies to normal operation when field length is not critical with respect to takeoff distance. This type of takeoff is based on a rotation speed of 190 KIAS for airplane gross weights of 110,000 pounds or more and 180 KIAS for all lower gross weights. This permits a variable liftoff speed and allows a slight margin for takeoff with tailwind before being restricted by tire limit speed (239 knots groundspeed).

The other type of takeoff applies to maximum performance operation where takeoff and rotation speeds are varied with gross weight so that takeoff speed corresponds to a lift coefficient of 0.60. Airspeeds at takeoff and the resultant ground run distance with this schedule

are always less than for the normal performance schedule. Pitch angle at takeoff is approximately 11° at 22% c.g. This schedule results in minimal tail clearance at liftoff. Therefore, this schedule is recommended only when the normal schedule or an intermediate schedule is inadequate for takeoff or refusal requirements and/or tailwind conditions.

Normal Takeoff Performance and Rotation Speed Schedule

The normal performance takeoff speed is based on a constant nosewheel liftoff speed of 190 knots for gross weights of 110,000 pounds or more and 180 knots for gross weights less than 110,000 pounds. Time from nosewheel off to main gear off is assumed to be 4.5 seconds, based on average rotation time from test data. (Start of stick input to initiate rotation should anticipate nosewheel off by about 15 knots or 2.5 seconds.) The normal performance takeoff speed schedule based on constant rotation speed is incorporated in the takeoff ground run distance chart. When the takeoff is to be made with a tailwind component, the nosewheel liftoff speed may be decreased slightly, if necessary, to avoid exceeding tire limit speed. Takeoff speed is also reduced by one knot per knot decrease in rotation speed. Reducing the rotation and takeoff speeds results in a one percent decrease in ground run distance per knot decrease in airspeed.

The normal performance takeoff speed provides a margin of control during climbout in the event of engine failure just after liftoff if immediate corrective action is taken. Takeoff speeds are higher than the minimum single engine control speeds for steady flight (speeds at which 5° to 10° of bank with up to 5° sideslip can be used to maintain flight path, utilizing up to full rudder deflection with maximum thrust on the operating engine. See figure 3-2). After takeoff, a sideslip and bank toward the operating engine are recommended with up to 9° rudder trim to minimize drag. The trim required decreases with increasing airspeed.

The takeoff speed schedule for normal performance is incorporated in the takeoff ground run distance chart, figure A2-1.

Maximum Performance Rotation and Takeoff Speed Schedule

The maximum performance rotation and takeoff speed schedules are shown in figure A2-2 as part of the takeoff distance chart. Maximum performance takeoff speeds are based on the takeoff attitude which provides a lift coefficient of 0.60 in ground effect at 22% c.g. Therefore, takeoff speed is a direct function of airplane gross weight and takeoff speeds are listed on the gross weight lines of the takeoff distance chart. Rotation or nosewheel liftoff speed is that speed where the airplane rotation is initiated and is scheduled to occur 4.5 seconds prior to liftoff. Rotation speeds are plotted on the chart as a function of ground run distance and as affected by wind and slope.

TAKEOFF GROUND RUN DISTANCE

Figures A2-1 and A2-2 present normal and maximum performance takeoff ground run distances as a function of ambient temperature, pressure altitude and gross weight. Correction grids for wind and slope effects are included. Limit tailwind areas are incorporated for reference and may be used as an indication of takeoff overspeed margin (the difference between takeoff speed and tire limit speed). The takeoff distances are based on test data and have no service allowance included.

Normal Performance Takeoff Ground Run Distance

Figure A2-1 shows normal performance takeoff distances obtained by use of the normal performance rotation speed and the takeoff speed schedules incorporated in this chart.

Example:

For an ambient temperature of 86°F, pressure altitude of 4500 feet and airplane gross weight of 120,000 pounds, determine the ground run distance and takeoff speed.

Enter figure A2-1 at the ambient temperature and pressure altitude, proceed horizontally to the gross weight and read down to determine a zero wind zero slope distance of 8300 feet. Continue down to the 190 knot rotation speed line (applicable to weights over 110,000 lb.) and read to the right horizontally to determine the zero wind and zero slope takeoff speed of 213 knots. For a headwind of 10 knots and a downslope of 1%, continue to read down to a distance of 7300 feet. The wind does not affect the takeoff speed but the 1% downhill slope decreases the takeoff speed to 212 knots.

Maximum Performance Takeoff Ground Run Distance

Figure A2-2 shows maximum performance takeoff distances consistent with the $C_L = 0.6$ maximum performance takeoff speeds and the rotation speed schedules which are also shown in this chart.

Example:

Using the same conditions as in the previous example, determine the maximum performance ground run distance, rotation speed and takeoff speed. Enter figure A2-2 at the temperature and pressure altitude condition, proceed horizontally to the gross weight and read down to the zero wind zero slope distance of 6700 feet. The takeoff speed listed on the distance line for 120,000 pounds is 192 knots. Continuing to read down, intersect the rotation speed curve, read to the right for the zero wind and zero slope rotation speed of 168 knots. Continuing vertically, determine the distance with wind and slope as 6050 feet. For the wind and slope case, the wind does not affect the rotation speed but the slope decreases the rotation speed to 167 knots.

Intermediate Takeoff Speed Schedule

When the normal performance schedule is inadequate because of runway length and takeoff weight and temperature, or other conditions, an intermediate takeoff speed should be considered before reverting fully to the maximum performance schedule. When rated tire speed is the limiting factor because of a tailwind condition, base the takeoff speed on the rated tire speed. Rated tire speed can be determined from figure 5-7. If a nominal "pad" of 5 knots is desired, the intermediate takeoff speed will be the rated tire speed minus the 5 knots. The corresponding takeoff distance can be obtained by using the following method: At the same temperature, pressure altitude, gross weight, wind and slope conditions, find the normal performance takeoff ground run distance. Subtract the intermediate takeoff speed from the normal takeoff speed. This number is equal to the percent reduction of the normal performance distance. Do not schedule takeoffs at speeds lower than the schedule for maximum performance.

Acceleration Check Speed

Figure A2-3 provides a means for making a speed check at any required distance during the takeoff run. Use the takeoff speed and distance values found from figures A2-1 or A2-2 to locate the position of a guide line on the acceleration check speed below the intersection of this guide line and the check distance value selected. The break in the acceleration lines at 50 knots approximates the change in acceleration as maximum thrust is obtained.

Example:

For example, in the 120,000 pound normal performance takeoff example where the zero wind distance was 8300 feet at 213 KIAS, the guide line illustrated shows that an acceleration check speed of 127 KIAS would be reached at a 3000-foot check distance. In the case where the takeoff run was 7300 feet with a 10 knot headwind and downslope, a guide line drawn from a point at 7300 feet and 212 KIAS intersects the 3000-foot check distance at 133 KIAS. The 3000-foot check distance point is recommended for operation at weights over 100,000 lb, since airspeeds reached at this distance allow reasonable accuracy in making the speed check. The 2000-foot check distance, however, is recommended at light weight or low temperature conditions.

Takeoff Fuel Allowance

Ramp fuel load can be adjusted to allow for fuel consumption up to the lift off point. Idle fuel flow is approximately 55 lb/minute/engine. Fuel consumption during a takeoff run is approximately 1000 pounds. A normal allowance for ground operation and takeoff would be 2000 pounds for a 10 minute ground operating period from first engine start, assuming 2 minutes is required to start the second engine.

REFUSED TAKEOFFS

Planning data for determination of acceleration check and refusal speeds may be obtained from the refusal speed charts, figures A2-4 through A2-7. Refusal speed without chute may be used as the acceleration check speed instead of the normal line speed check, if desired, provided the corresponding check distance is also computed. Either the scheduled rotation speed or the maximum refusal speed with chute, whichever is lower, is the maximum speed at which a decision to abort a takeoff is recommended.

The charts show actual maximum performance refused takeoff capability without conservatism or service allowances. However, various factors may contribute to performance less than optimum, such as blown tires, delay in drag chute deployment, etc. Brake energy capacity is assumed to be 90% of full rated one-stop capability, thus allowing some normal service use prior to the refused takeoff. This factor is presented as maximum refusal speed. For abort conditions where brake burn-out might occur before a stop can be made the aircraft is assumed to free roll at relatively low speed and not stop.

Refusal Speed With Drag Chute

The refusal speed with drag chute charts are shown in figures A2-4 and A2-5 for dry and wet runways, respectively. The abort speeds are given as function of temperature, pressure altitude and gross weight for available runway length. Assumptions made in the refusal speed calculations are as follows:

1. Normal rate of acceleration is maintained to the refusal speed at which time complete and instantaneous loss of one engine occurs.

2. Maximum afterburning thrust is maintained on the operating engine and zero thrust is obtained from the failed engine for 3 seconds before the throttle on the operating engine is retarded to idle.

   Note

   No rotation is attempted when a takeoff emergency occurs before reaching rotation speed, even though airspeed may exceed rotation speed during this recognition and action period.

3. If the takeoff is aborted after rotation has been initiated, aerodynamic braking is utilized until the aircraft has decelerated to chute deployment speed of 190 knots. (Refer to ABORT procedure, Section III.)

4. The nose is lowered before brake application if aerodynamic braking has been required. (See 3 above.)

5. Braking torque is obtained one second after retarding the throttles unless rotation has been initiated. The allowance for chute full deployment is 4.75 seconds after drag chute switch actuation.

6. Optimum wheel braking is continued until the aircraft is stopped.

7. Drag chute is jettisoned at 60 knots on a dry runway and is retained to full stop on a wet runway. (The chute should always be retained until stopping is assured.)

8. Zero wind and zero sope.

9. Hard surface runway. (The effects of water, slush, or snow on acceleration have not been considered.)

10. The takeoff is continued if rotation has been initiated prior to an engine failure when a positive climbout capability exists.

Example:

Using the same conditions as in the takeoff example, i.e., 86°F temperature, 4500 feet pressure altitude, 120,000 pounds gross weight, find the refusal speed with drag chute for a 12,000 foot dry runway.

Enter figure A2-4 at the temperature and pressure altitude conditions, proceed horizontally to the gross weight, then downward to the available runway length (accelerate and stop distance available) and read a refusal speed of 170 knots. (This refusal speed is usable only if 90% of the brake energy isn't exceeded.) Proceed downward to 120,000 lb dashed line and read a maximum refusal speed of 135 knots and interpolate the distance to accelerate and stop as 8500 ft.

Using the same procedure for the wet runway case, enter figure A2-5 and read a refusal speed of 151 knots.

Refusal Speed Without Drag Chute

Refusal speeds without drag chute are presented in figures A2-6 and A2-7 for dry and wet runways, respectively. The refusal speeds are given as a function of temperature, pressure altitude and gross weight for the available runway length. Assumptions made in the no chute refusal speed calculations are the same as those made for calculating refusal speeds with chute with the following exceptions:

1. Drag chute deployment is attempted as the nose is lowered at 190 KIAS (if rotation has been accomplished) or at start of braking if aborting from a lower speed. Drag chute failure recognition is normal chute deploy time of 4.75 seconds plus 3.0 seconds recognition time.

2. With a wet runway, one engine is shut down after recognition of chute failure, up-elevon drag is used (but the nose down attitude maintained), anti-skid is turned off and the stop is with all tires blown.

Example:

Using the same conditions as in the previous examples, find the refusal speed for dry and wet runways.

For a dry runway, enter figure A2-6 at the temperature and altitude conditions, proceed horizontally to the gross weight, then proceed downward to the

maximum refusal speed line for 120,000 lbs and read a maximum refusal speed of 112 knots. Using the same procedures for the wet runway conditions, enter figure A2-7 and read a refusal speed of 107 knots.

SINGLE ENGINE CLIMB CAPABILITY

Three curves of single engine climb capability are supplied to show the effect of speed and temperature as an aid in judging performance at takeoff weight with maximum thrust. Figures A2-8, A2-9 and A2-10, show the effect of airspeed on maximum weight for gear down in ground effect, gear up in ground effect, and gear up out of ground effect, respectively. The illustrated performance represents wind tunnel tests results. A degradation factor of 10,000 lb should be applied before use and a supplemental scale incorporating this factor is provided. The values shown are for cg = 22% MAC. For deviation from 22% cg, decrease gross weight by 1500 lb for each one-percent forward shift from 22% cg, or increase gross weight by 1500 lb for each one-percent aft shift from 22% cg. If operating at less than the maximum weight for climbout, the excess thrust indicated by the maximum weights shown can be used for acceleration and delayed climb, instead of immediate climb at low airspeeds. This procedure is usually permitted by the takeoff situation at the operating base. The best climb speed with gear down close to the ground is approximately 250 KIAS. The gear would ordinarily be retracting during an acceleration to this speed, so the value represents a target speed for transition to a shallow climb attitude. The best single engine climb speed with gear up away from ground effect is above 400 KIAS; however, 300 KIAS provides an adequate angle for single engine climb to pattern altitudes. In normal operation, 300 KIAS represents a target speed for gradual pullup to normal climb speed.

Example:

Using the same conditions as on the takeoff case for gear down in ground effect find the single engine capability speed. Enter figure A2-8 at 86°F and 4500 ft altitude and using the temporary decrement weight scale gives the speed as over 250 KEAS. Use of the gear up out of ground effect curve, figure A2-10, gives the speed as 232 KEAS.

LANDING FIELD LENGTH REQUIREMENTS

Landing speed schedules and landing rollout distance information are provided for dry and wet runways, with and without drag chute, and for normal and maximum performance techniques.

NORMAL AND MAXIMUM PERFORMANCE LANDING SPEED SCHEDULES

Figure A2-11 shows the normal and maximum (heavy weight) performance landing speed schedules as a function of gross weight down to 60,000 pounds. At gross weights less than 60,000 pounds the landing speed is a constant 145 KIAS for normal performance and 135 KIAS for maximum performance operation. The maximum performance landing speeds are 10 knots less than normal landing speeds for all weight conditions.

In addition to the landing speed schedule, the tailwind at which tire limit speed will be exceeded may be obtained from this chart.

Example:

1. For a normal landing at 70,000 pounds gross weight, determine final approach and landing speeds and limit tailwind for a pressure altitude of 4500 feet and ambient temperature of 86°F.

   Enter the chart at 70,000 pounds, proceed up to intercept the normal approach speed line at 175 KIAS and the normal landing speed schedule at 155 KIAS. Enter the temperature altitude chart at 86°F and 4500 feet, read up to intersect the 155 knot landing speed line. This determines the limit tailwind component to avoid exceeding tire limit speed as over 30 knots.

2. Determine final approach and landing speeds and limit tailwind for touchdown at 120,000 pounds, 4500 feet pressure altitude and 86°F ambient temperature. Enter the chart at 120,000 pounds gross weight, proceed up to intercept the final approach speed schedule at 235 KIAS and the heavy weight landing schedule line at 195 KIAS. Enter the temperature-altitude chart at 86°F, proceed horizontally to the 4500 foot line, read up to the intersection with the 195 knot landing speed line, and read 22 knots as the limit tailwind component.

LANDING GROUND ROLL DISTANCE

Normal Performance Landing Ground Roll Distance With Drag Chute

The normal performance landing ground roll distance with drag chute for dry and wet runways is shown in figures A2-12 and A2-13, respectively. Performance is given as a function of ambient temperature, pressure altitude and gross weight. Wind and slope effects are included. Standard landing technique assumes chute deploy switch actuation approximately 1 second after touchdown, chute fully deployed approximately 6 seconds after touchdown, and the nose down at 120 KIAS. Full braking pressure requires about 1 second after initial pedal depression. The chute is assumed to be jettisoned at 60 knots for the dry runway case and is retained to full stop for wet runway conditions.

Example:

For conditions of 86°F air temperature, 4500 feet pressure altitude and 70,000 pounds gross weight, find the normal performance landing ground roll distance with drag chute.

1. Enter figure A2-12 for the dry runway at the temperature and altitude condition, proceed horizontally to the gross weight and read downward to determine zero wind, zero slope ground roll distance of 4100 feet. For a headwind of 10 knots and a downhill slope of 1% the ground roll distance would be 3700 feet, as shown in the chart.

2. Applying the same procedure in the wet runway chart, figure A2-13, shows a zero wind, zero slope distance of 5950 feet. For the wind and slope case the distance would be 5300 feet.

Normal Performance Landing Ground Roll Distance Without Drag Chute

Normal performance landing ground roll distance for landing without chute is shown in figures A2-14 and A2-15 for dry and wet runways. Normal performance without chute assumes the same sequence of events as for landing with chute. The nose of the airplane is lowered at or before reaching 120 KIAS and brakes applied. In the no chute wet runway case it is assumed that one engine is shut down and anti-skid is turned off at start of braking.

Example:

Using the same conditions as in the landing with chute example, find the normal performance landing distance without drag chute.

1. For the dry runway case, enter figure A2-14 at the ambient temperature and pressure altitude conditions, proceed horizontally to the gross weight, then read downward to determine a zero wind, zero slope ground roll distance of 8500 feet. With wind and slope, the distance is 7900 feet as shown in the chart.

2. For a wet runway condition, the zero wind and slope distance is 13,800 feet, as shown in figure A2-15. The wind and slope distance is 13,100 feet.

Maximum Performance Landing Ground Roll Distance With Drag Chute

When using the minimum roll landing technique, distances with drag chute may be obtained in figures A2-16 and A2-17 for dry and wet runways, respectively. Performance is given as a function of temperature, pressure altitude, and gross weight. Wind and slope effects are included. Minimum roll technique assumes touchdown at 10 knots slower speed than normal. If touchdown is at speeds less than 190 knots, chute deployment is assumed to be initiated and the nose lowered as soon as the main gear touches. If at speeds over 190 knots, chute deployment and lowering the nose is delayed until 190 knots is reached. Brakes are applied as soon as the nose gear is on the ground. The chute is assumed jettisoned at 60 knots for the dry runway and is retained to full stop for the wet runway.

Example:

Using the same conditions as in the normal landing examples for 70,000 lb find the maximum performance landing distance with chute.

1. For the dry runway case, enter figure A2-16 at the ambient temperature and pressure altitude, proceed horizontally to the gross weight. Read downward to determine a zero wind, zero slope ground roll distance of 3600 feet. With wind and slope the distance is 3300 feet.

2. In the case of a wet runway, the zero wind, zero slope distance is 5500 feet as shown in figure A2-17. The wind and slope effect gives a distance of 4900 feet.

Maximum Performance Landing Ground Roll Distance Without Drag Chute

Maximum performance landing distances without drag chute are presented in figures A2-18 and A2-19 for dry and wet runways, respectively. The same sequence of events is assumed as for landings with the drag chute. A three second recognition time of chute failure is incorporated before shutdown of the right engine and turning anti-skid off for the wet runway landing.

Example:

Using the same conditions as used previously, find the maximum performance landing distance without chute.

1. For the dry runway case enter figure A2-18 at the ambient temperature and pressure altitude, proceed horizontally to the gross weight. Read downward to determine a zero wind, zero slope distance of 6450 feet. Continuing through the wind and slope corrections gives a distance of 5800 feet.

2. In the wet runway case, the zero wind and zero slope distance is 13,200 feet as shown in figure A2-19. With wind and slope, the distance is 12,600 feet, as shown in the chart.

TAKEOFF AND LANDING DATA CARD EXAMPLE

T.O. wt 120,000 Lb Press alt 4500 Ft

Runway temp 86 °F Wind (H-T) 10 Kn

Grade 1 % (Up-Dn) Runway Dry - Wet

Acceleration check speed

@ 3000 ft (____ marker) 133 KIAS

Predicted ground run 7300 Feet

Rotation 190 KIAS

Takeoff . . . 212 KIAS

Min single engine (gear down 0 wind) over 250 KIAS

Runway length available 12,000 Feet

Max refusal with chute (0 wind) 135 KIAS

Max braking with chute No Limit KIAS

Max refusal no chute (0 wind) 112 KIAS

Max braking no chute 123 KIAS

Runway available 12K Ft Press alt 4500 Ft

Runway temp 86 °F Wind (H--T) 0 Kn

Grade 0 % (Up-Dn) Runway Dry - Wet

Fuel remaining	KIAS Approach	KIAS Land	Landing Roll* Chute	Landing Roll* No chute
15,000	175	155	4100	8500 Ft

Landing Immediately After Takeoff:

115,000 Lb	220	190	6200	11,400 Ft

MAXIMUM BRAKING SPEEDS:

Fuel remaining	Chute	No chute
15,000 Lb	No Limit	158 KIAS

Landing Immediately After Takeoff:

115,000 Lb	No Limit	115 KIAS

* ± 1% per knot head or tail wind component.

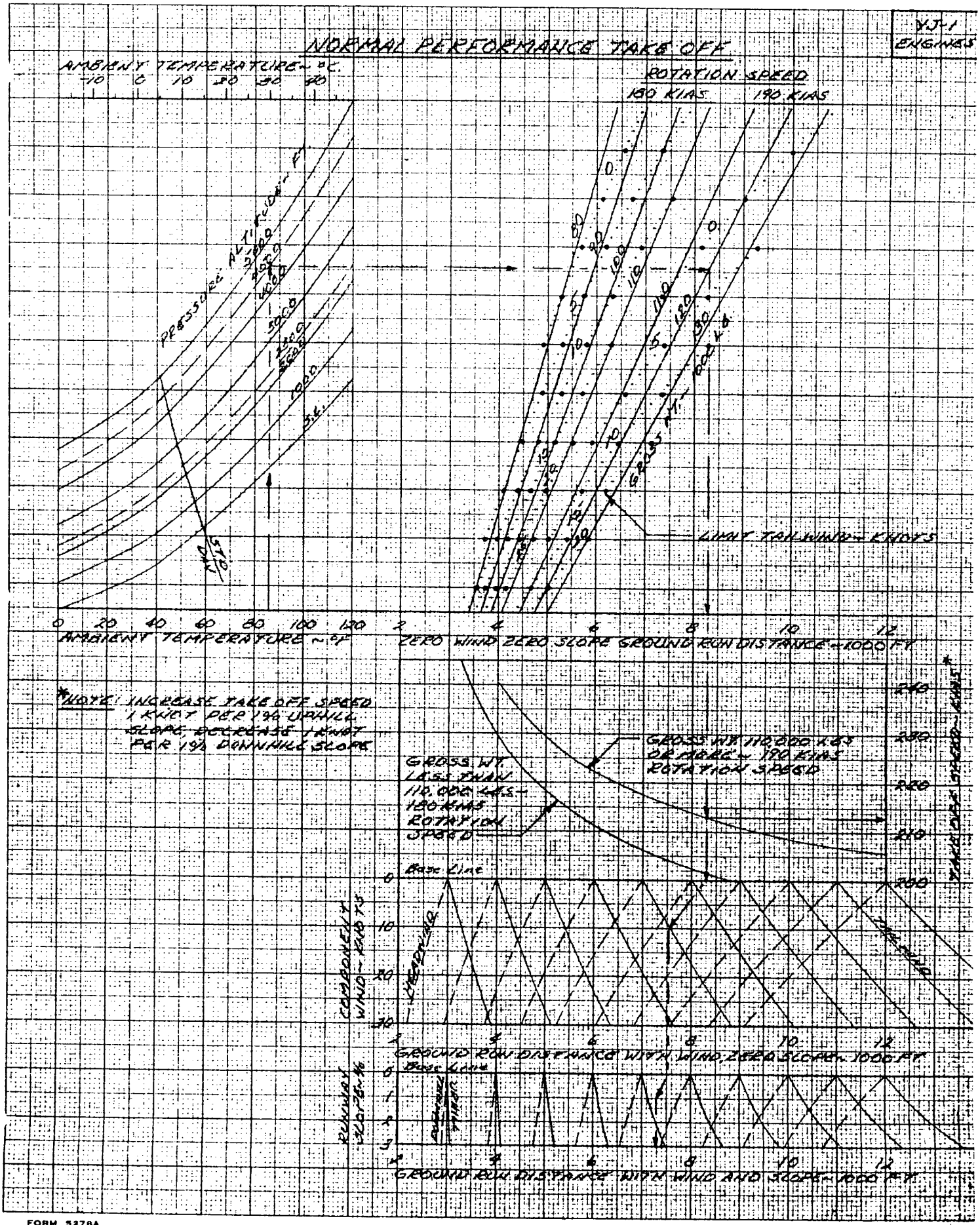

NORMAL PERFORMANCE TAKE OFF
YJ-1 ENGINES
AMBIENT TEMPERATURE ~ °C
ROTATION SPEED
190 KIAS
190 KIAS
PRESSURE ALTITUDE ~ FT
STD DAY
LIMIT FOR WIND ~ KNOTS
AMBIENT TEMPERATURE ~ °F
ZERO WIND ZERO SLOPE GROUND ROLL DISTANCE ~ 1000 FT
*NOTE: INCREASE TAKE OFF SPEED 1 KNOT PER 1% UPHILL SLOPE, DECREASE 1 KNOT PER 1% DOWNHILL SLOPE
GROSS WT. LESS THAN 110,000 LBS ~ 190 KIAS ROTATION SPEED
GROSS WT. 110,000 LBS OR MORE ~ 190 KIAS ROTATION SPEED
Base Line
HEADWIND
TAILWIND
CROSSWIND ~ KNOTS
GROUND ROLL DISTANCE WITH WIND, ZERO SLOPE ~ 1000 FT
Base Line
RUNWAY SLOPE ~ %
GROUND ROLL DISTANCE WITH WIND AND SLOPE ~ 1000 FT

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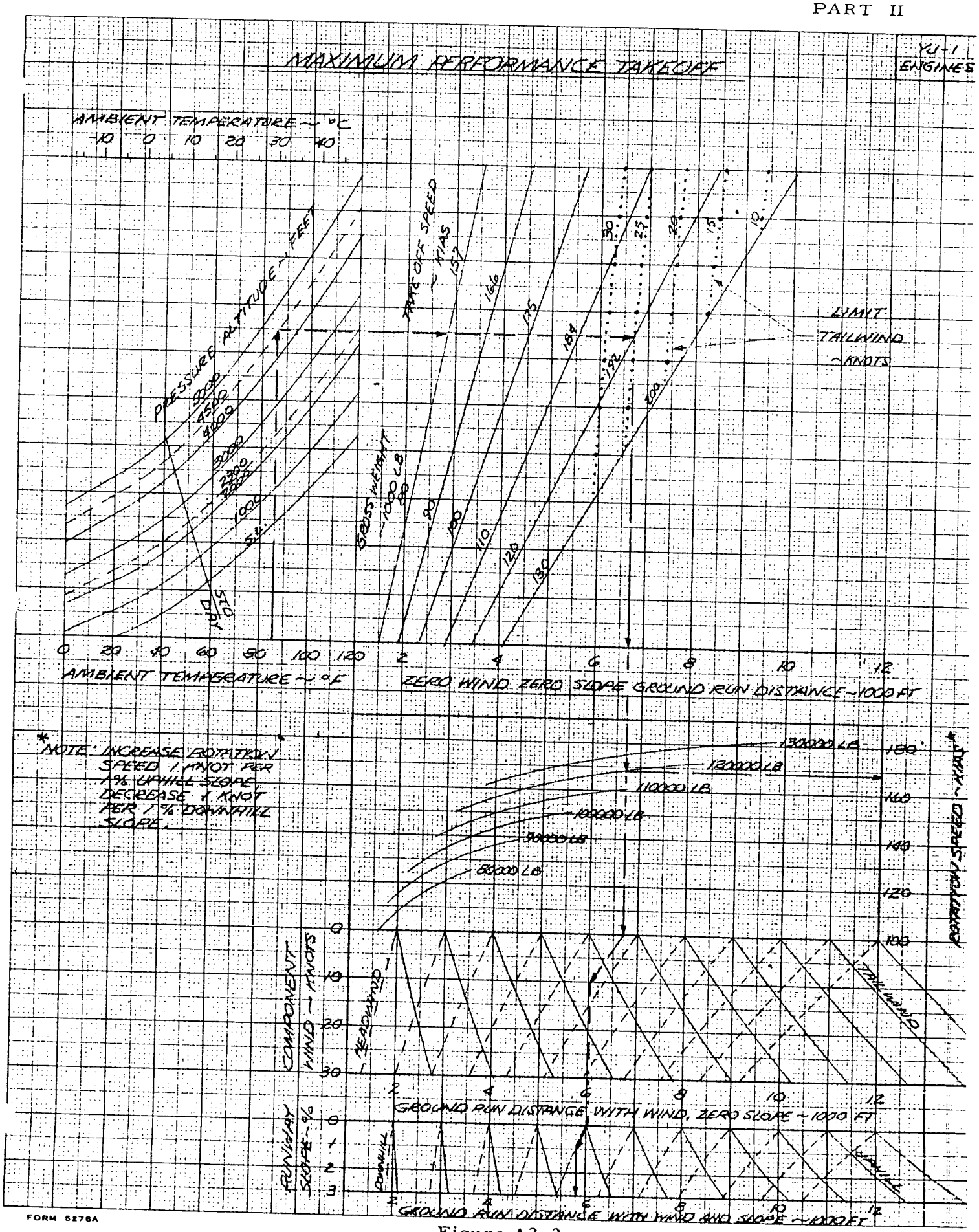
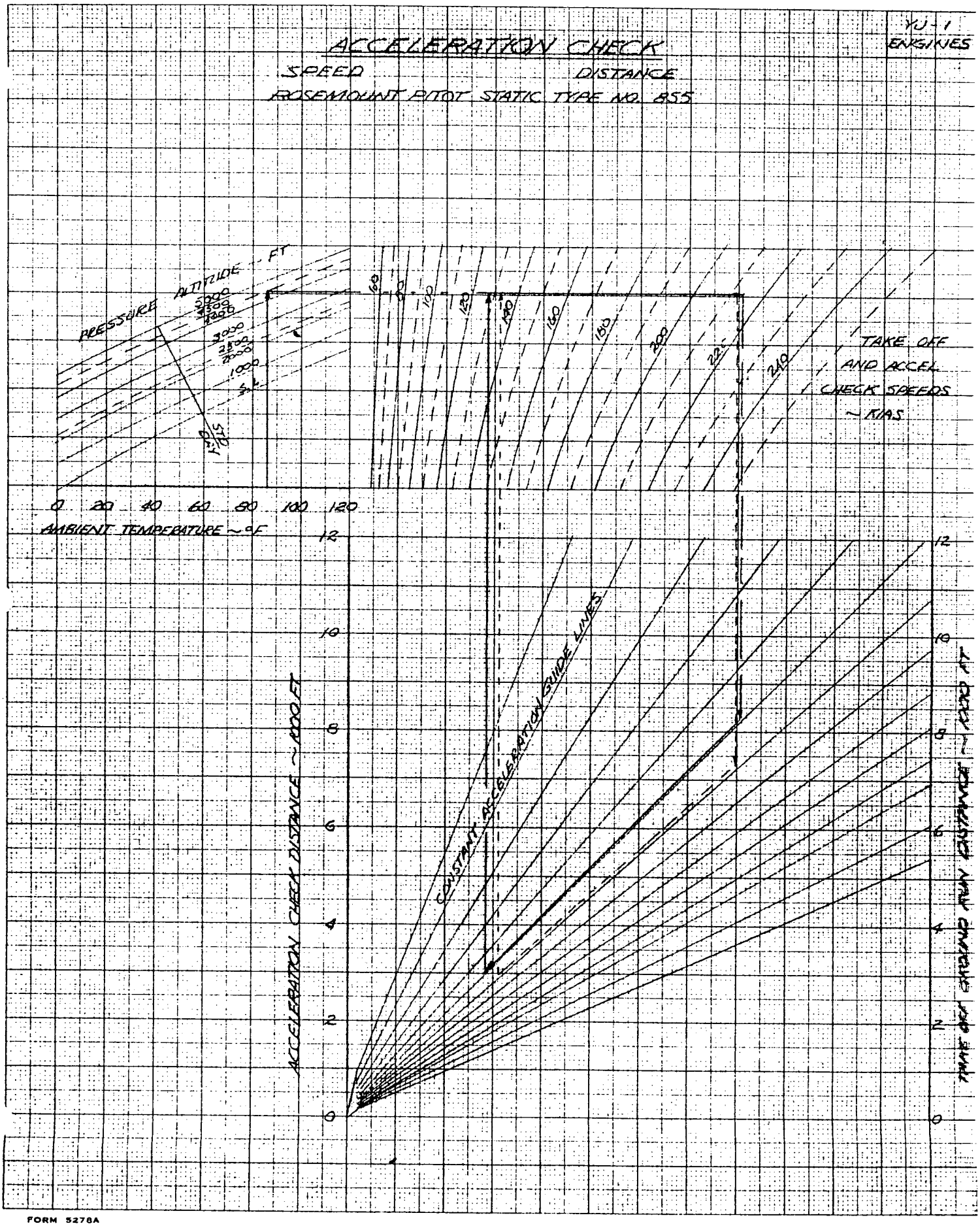
Figure A2-1


MAXIMUM PERFORMANCE TAKEOFF
YJ-1 ENGINES
AMBIENT TEMPERATURE ~ °C
-10 0 10 20 30 40
PRESSURE ALTITUDE ~ FEET
STD DRY
TAKE OFF SPEED ~ KIAS
GROSS WEIGHT ~ 1000 LB
LIMIT TAILWIND ~ KNOTS
AMBIENT TEMPERATURE ~ °F
ZERO WIND ZERO SLOPE GROUND RUN DISTANCE ~ 1000 FT
* NOTE: INCREASE ROTATION SPEED 1 KNOT PER 1% UPHILL SLOPE, DECREASE 1 KNOT PER 1% DOWNHILL SLOPE.
130000 LB
120000 LB
110000 LB
100000 LB
90000 LB
80000 LB
TAKE OFF SPEED ~ KIAS
HEADWIND
TAILWIND
COMPONENT WIND ~ KNOTS
RUNWAY SLOPE ~ %
DOWNHILL
UPHILL
GROUND RUN DISTANCE WITH WIND, ZERO SLOPE ~ 1000 FT
GROUND RUN DISTANCE WITH WIND AND SLOPE ~ 1000 FT

FORM 5276A

Figure A2-2



LEARPRINT CHARTS

FORM 5278A

Figure A2-3

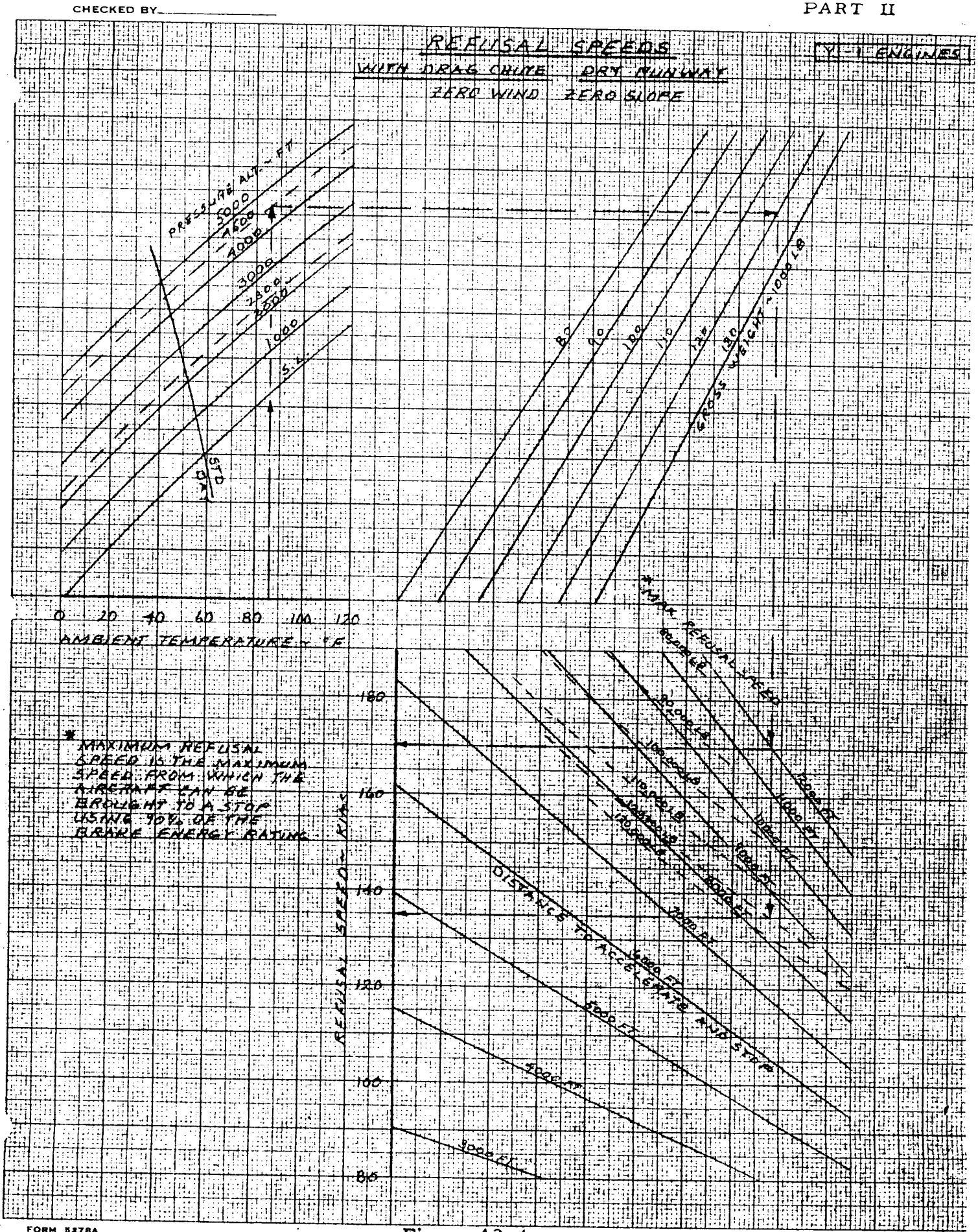

REFUSAL SPEEDS
WITH DRAG CHUTE DRY RUNWAY
ZERO WIND ZERO SLOPE
2 ENGINES
PRESSURE ALT - FT
5000
4600
4000
3000
2400
2000
1000
SEA LEVEL
STD DAY
0 20 40 60 80 100 120
AMBIENT TEMPERATURE - °F
80
90
100
110
120
130
GROSS WEIGHT - 1000 LB
FLIGHT IDLE THRUST
REFUSAL SPEED - KIAS
160
140
120
100
80
* MAXIMUM REFUSAL SPEED IS THE MAXIMUM SPEED FROM WHICH THE AIRCRAFT CAN BE BROUGHT TO A STOP USING 70% OF THE BRAKE ENERGY RATING
DISTANCE TO ACCELERATE AND STOP
5000 FT
4000 FT
3000 FT
2000 FT
1000 FT

Figure A2-4

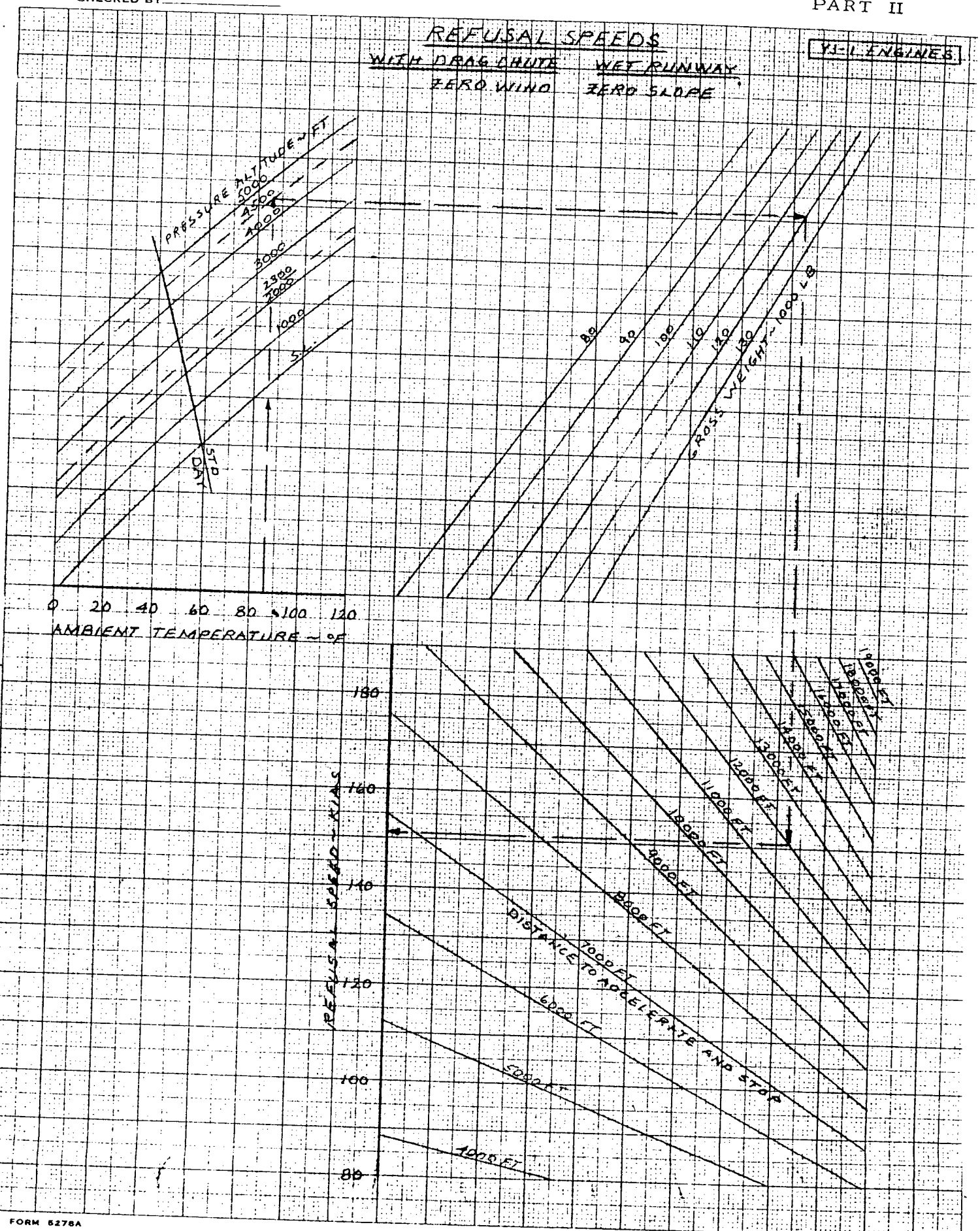


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Figure A2-5

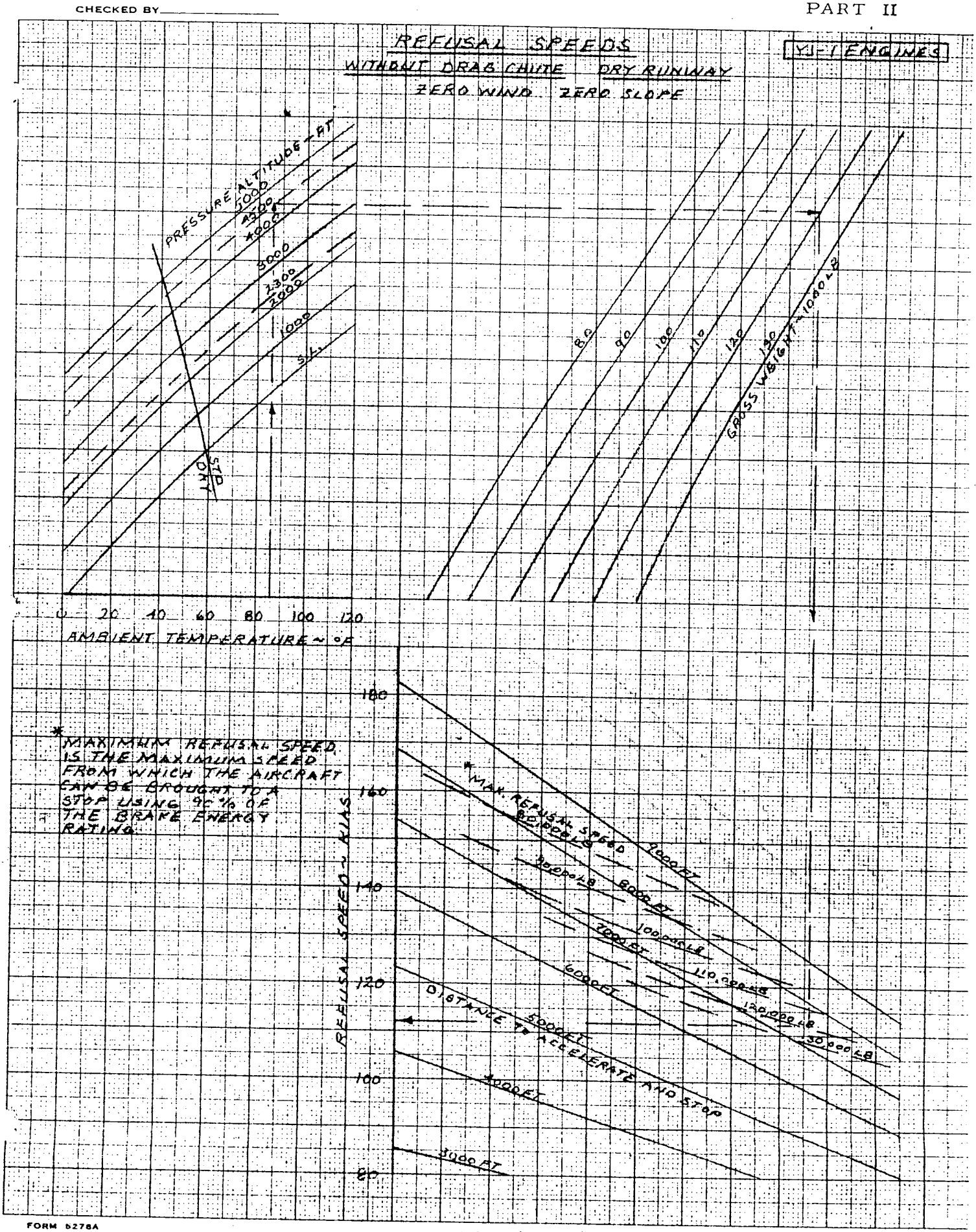

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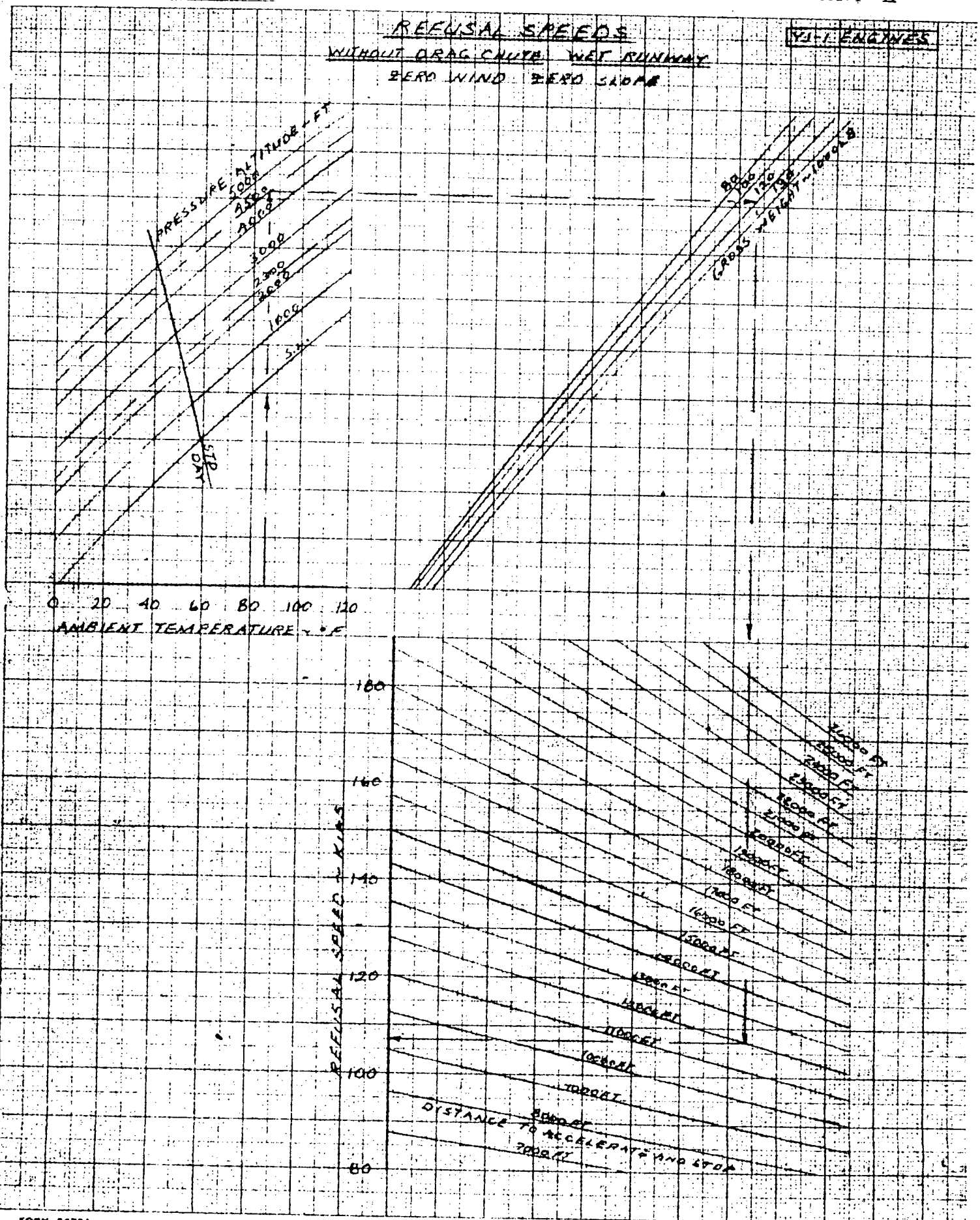
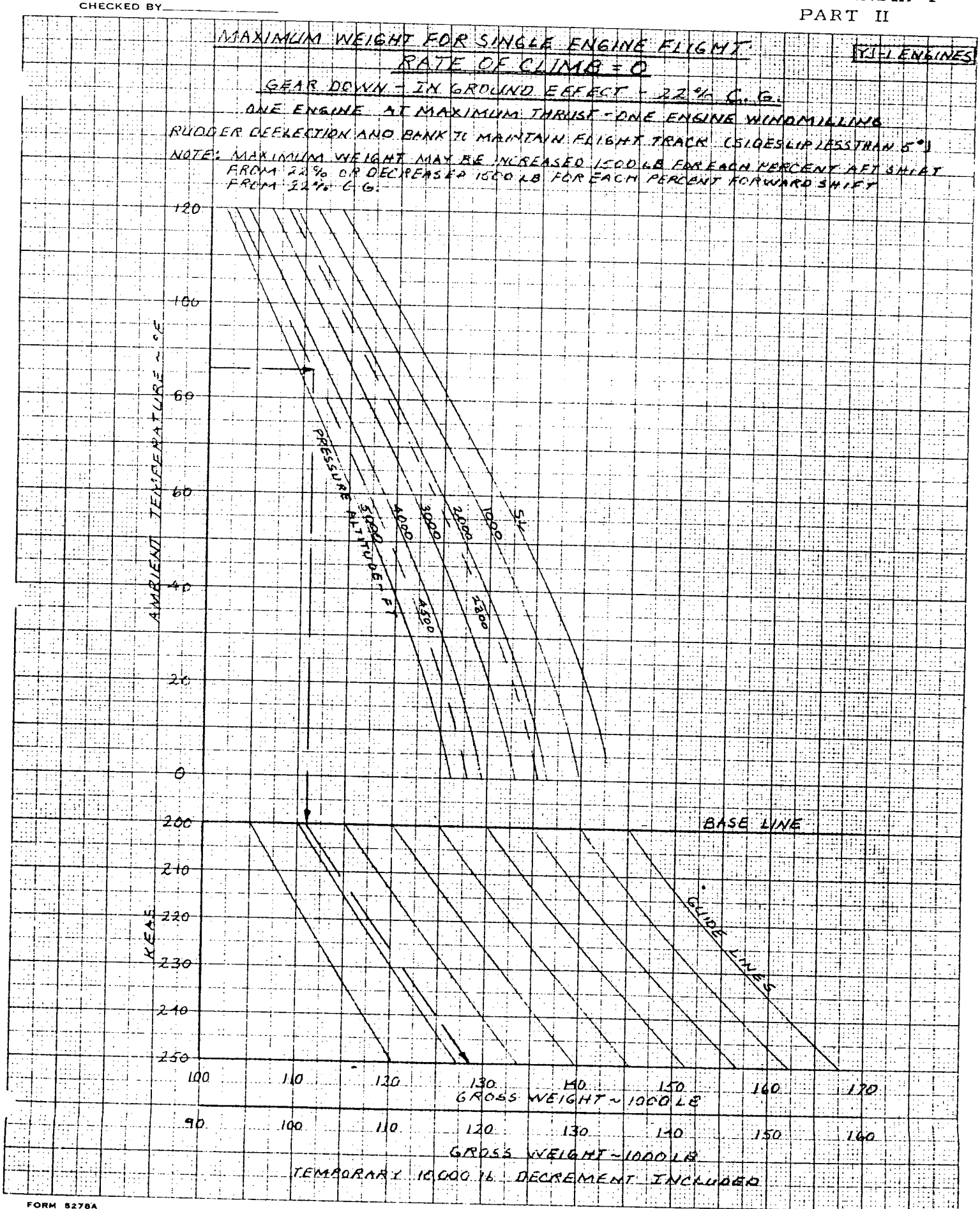
Figure A2-6



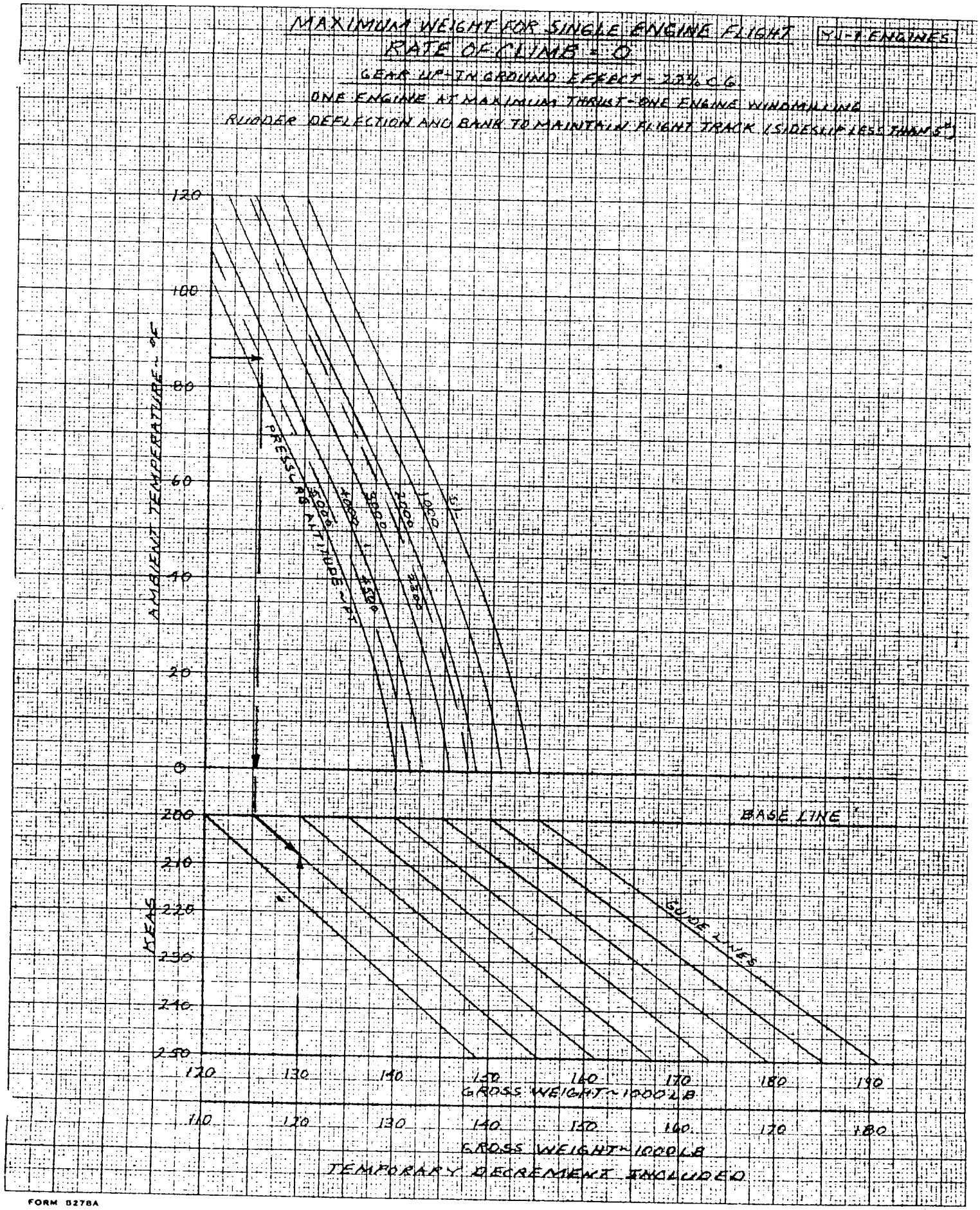
FORM 6276A

Figure A2-7


MAXIMUM WEIGHT FOR SINGLE ENGINE FLIGHT
RATE OF CLIMB = 0
GEAR DOWN - IN GROUND EFFECT - 22% G.G.
ONE ENGINE AT MAXIMUM THRUST - ONE ENGINE WINDMILLING
RUDDER DEFLECTION AND BANK TO MAINTAIN FLIGHT TRACK (SLIDESLIP LESS THAN 5°)
NOTE: MAXIMUM WEIGHT MAY BE INCREASED 1600 LB FOR EACH PERCENT AFT SHIFT FROM 22% G.G.
DECREASED 1600 LB FOR EACH PERCENT FORWARD SHIFT
YJ-1 ENGINES
AMBIENT TEMPERATURE ~ °C
KEAS
PRESSURE ALTITUDE FT
SL
1000
2000
3000
4000
5000
BASE LINE
GUIDE LINES
GROSS WEIGHT ~ 1000 LB
GROSS WEIGHT ~ 1000 LB
TEMPORARY 16,000 LB DECREMENT INCLUDED

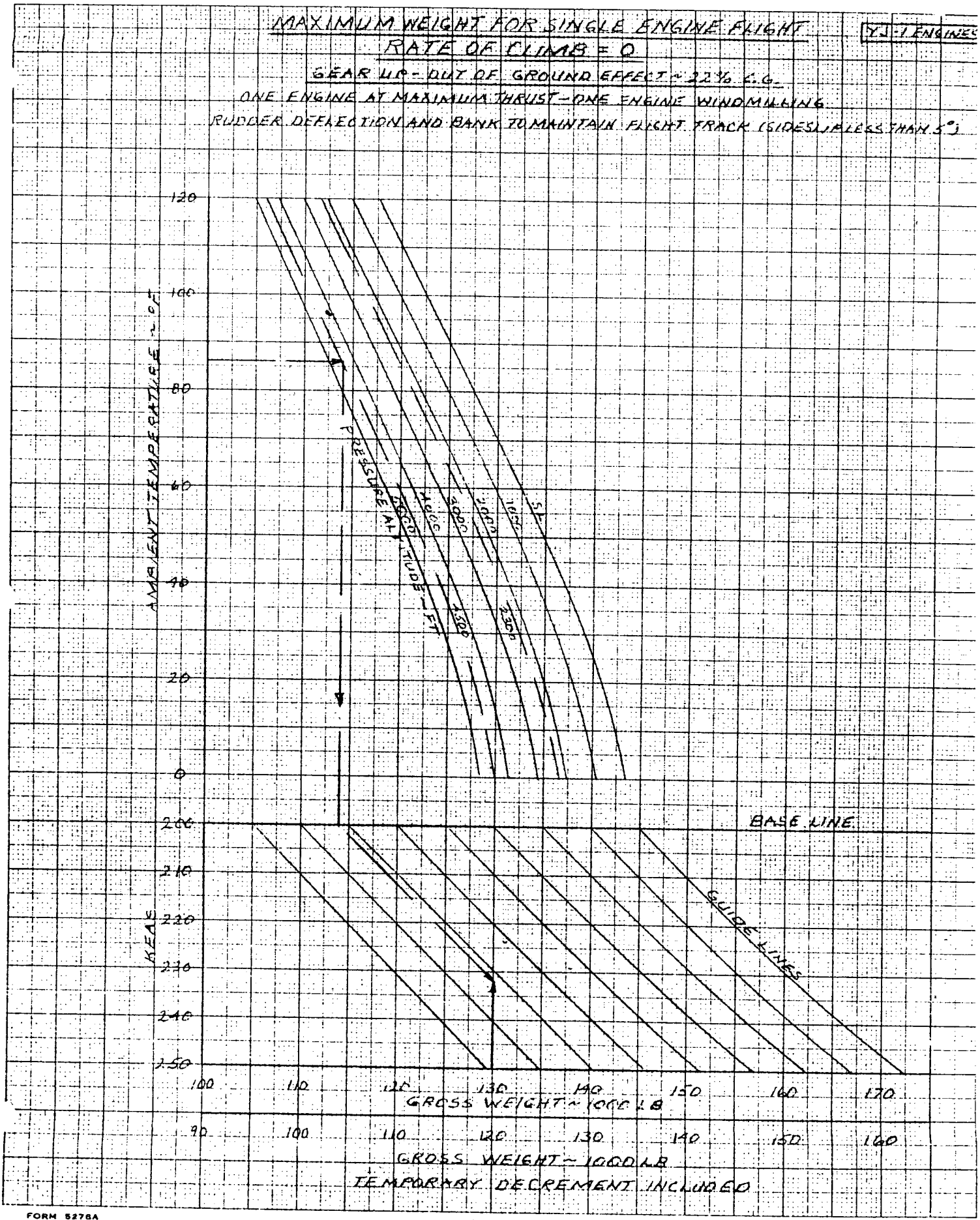
FORM 5278A

Figure A2-8



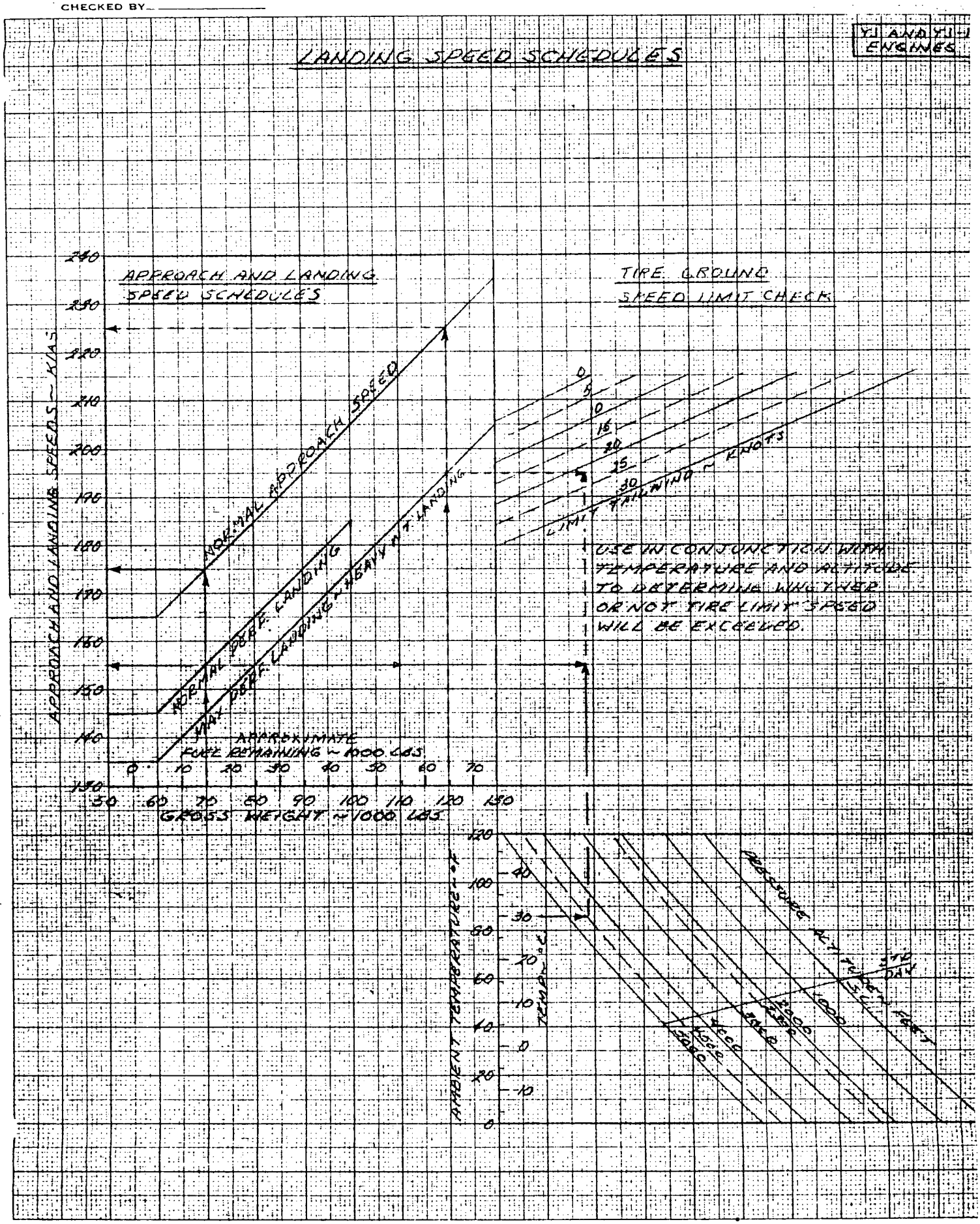
FORM 8278A

Figure A2-9



FORM 5276A

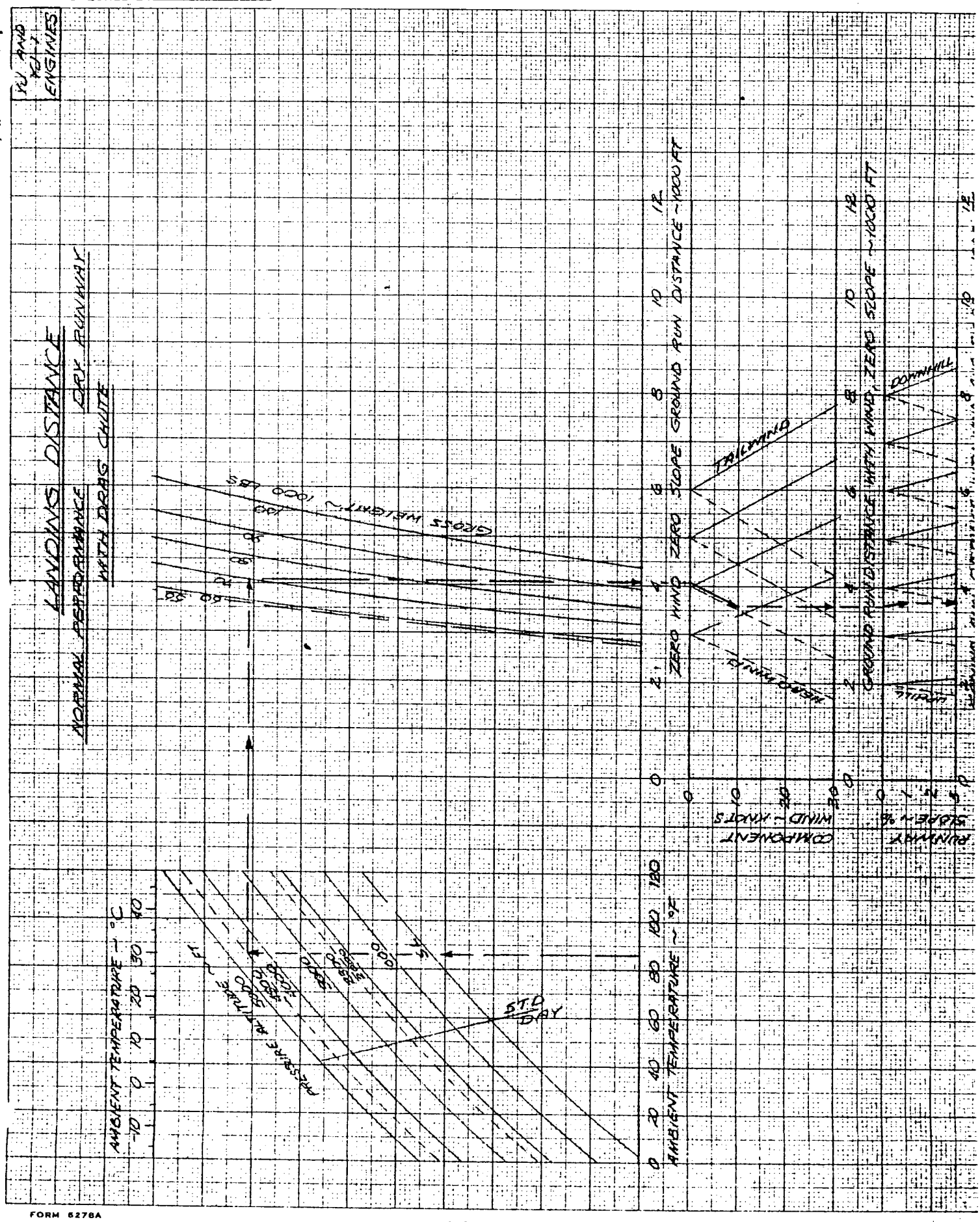
Figure A2-10



CLEARPRINT CHARTS

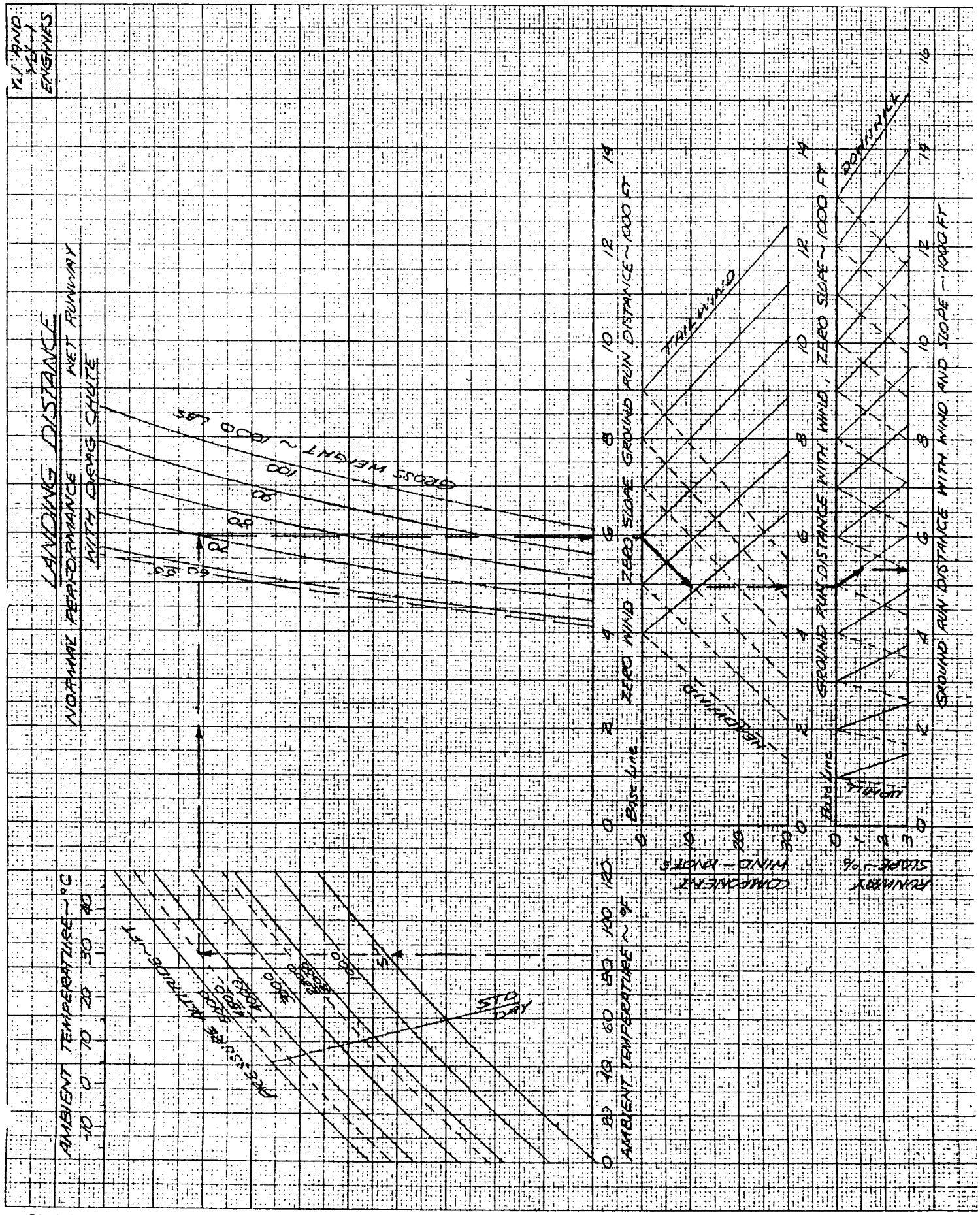
FORM 5278A

Figure A2-11



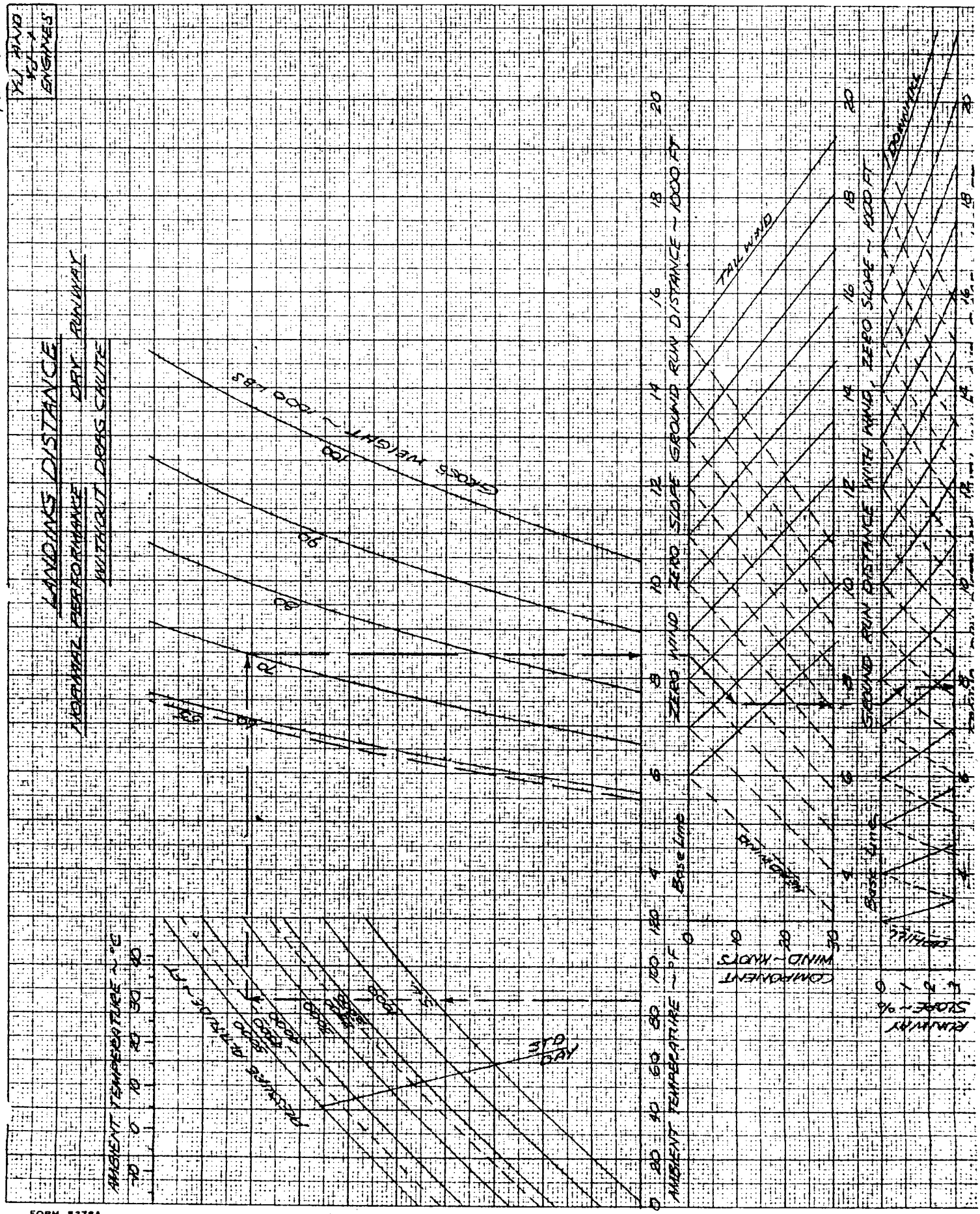
FORM 5278A

Figure A2-12



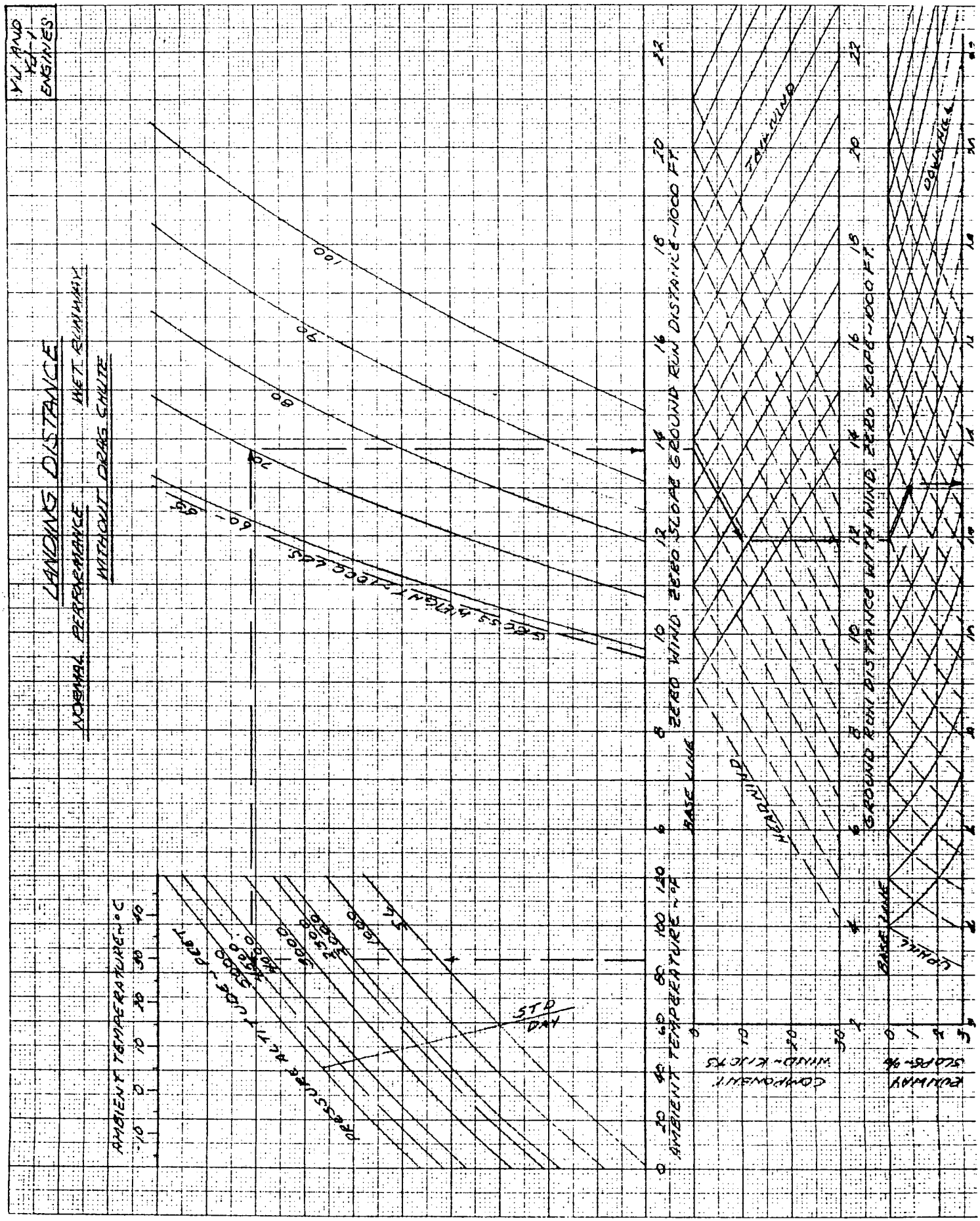
FORM 5278A

Figure A2-13



FORM 8278A

Figure A2-14



FORM 5278A

Figure A2-15

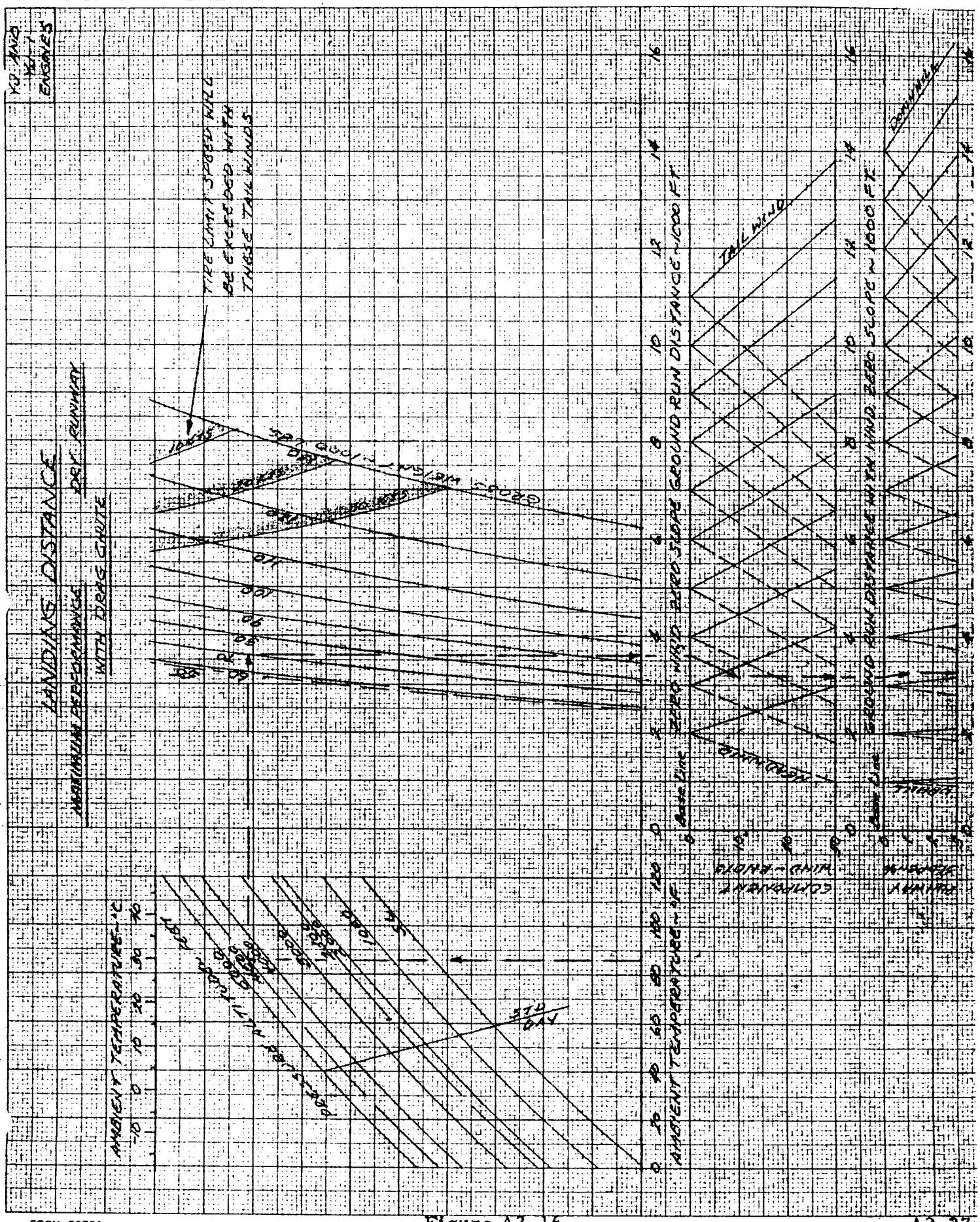
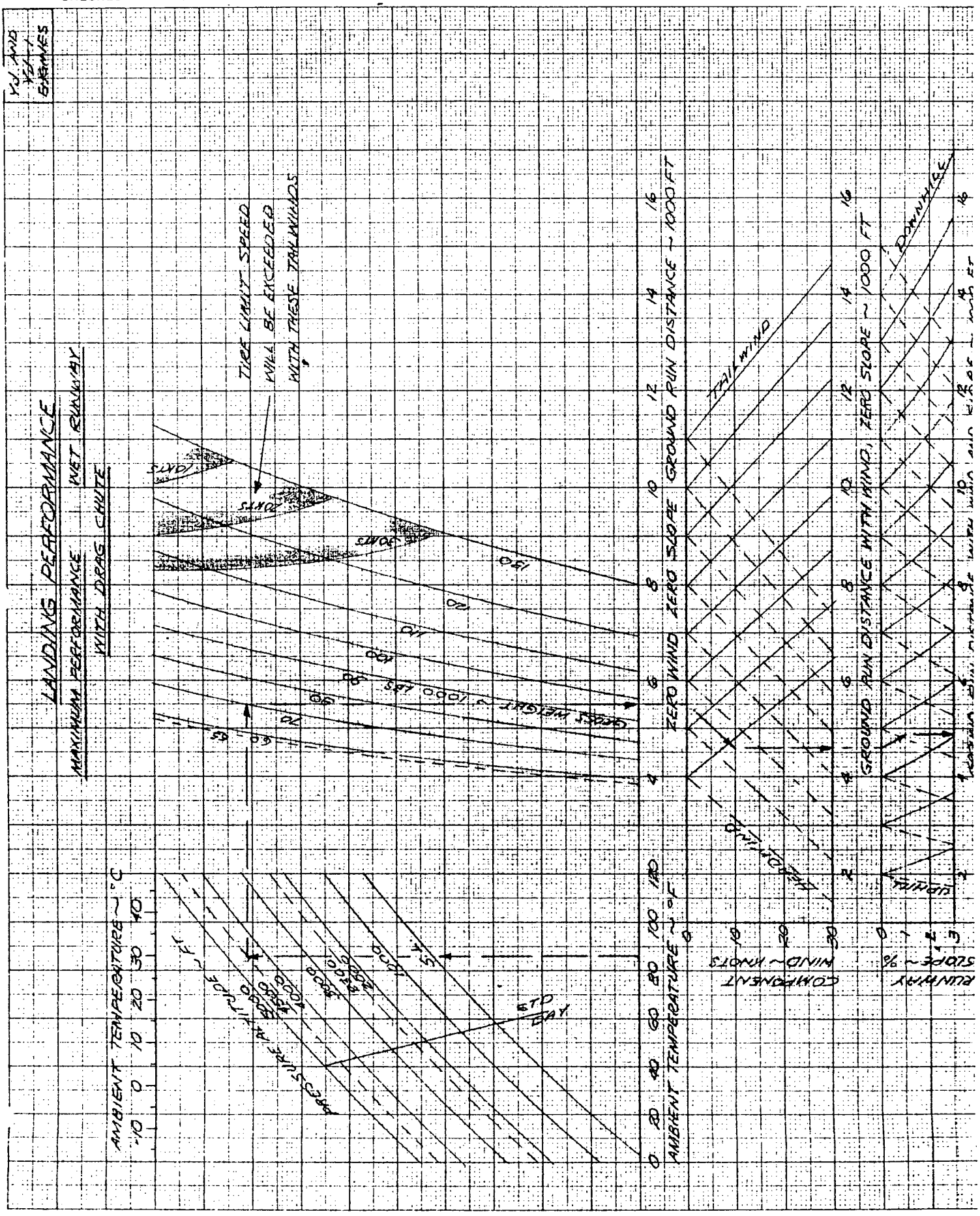

TAKEOFF DISTANCE
MAXIMUM REVERSE THRUST
WITH ZERO CRUISE
ENGINES
TAKEOFF DISTANCE
MAXIMUM REVERSE THRUST
WITH ZERO CRUISE
TAKE LIMIT STOPPING MAY BE EXCEEDED WITH THESE TAILWINDS
AMBIENT TEMPERATURE - °C
AMBIENT TEMPERATURE - °F
ZERO WIND ZERO SLOPE GROUND RUN DISTANCE - 1000 FT
GROUND RUN DISTANCE WITH 10 KNOT ZERO SLOPE ~ 1000 FT
TAILWIND
HEADWIND
Sea Level
Runway
Pressure
Altitude
Feet

Figure A2-16



FORM 5278A

Figure A2-17

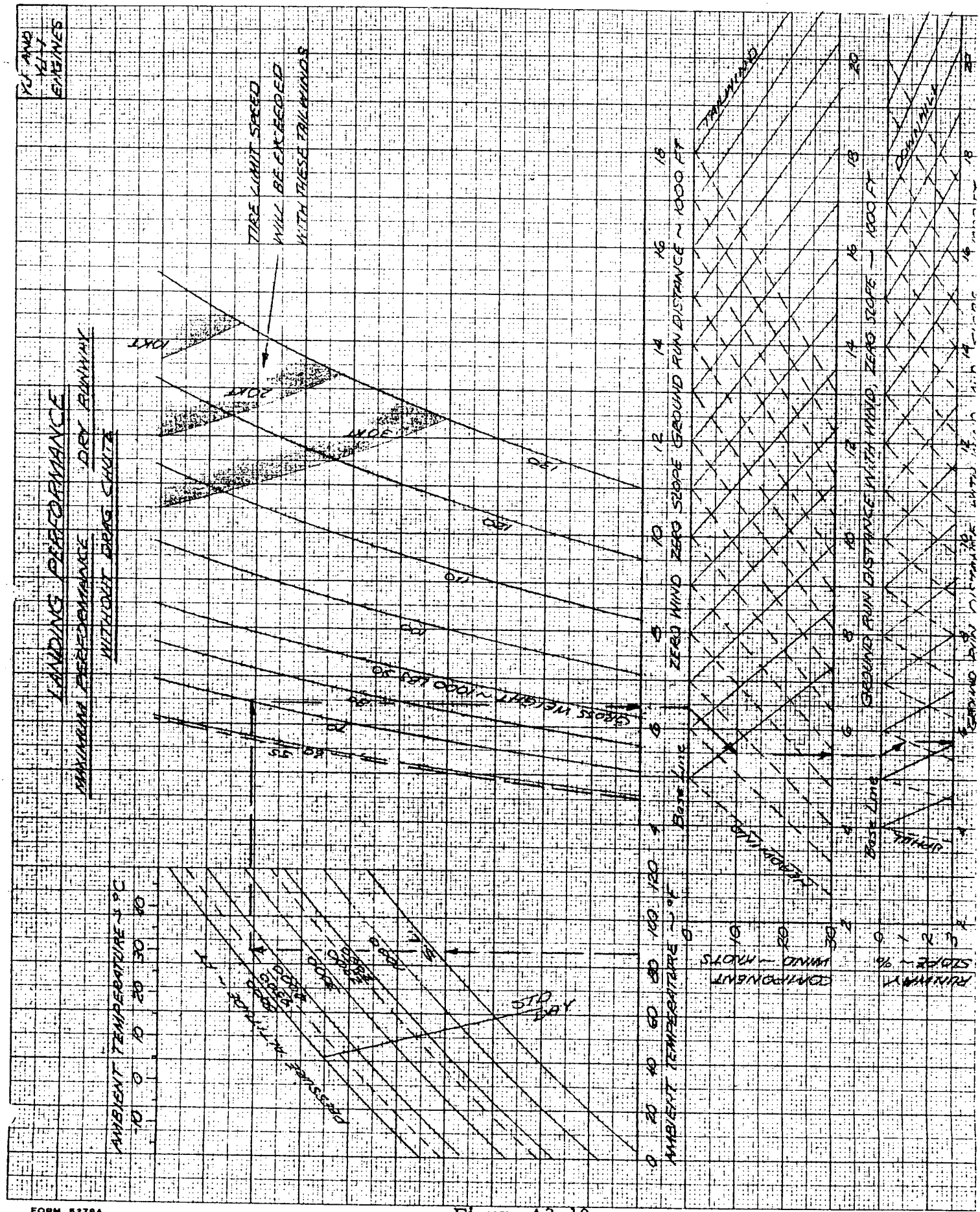

LANDING PERFORMANCE
MAXIMUM PERFORMANCE
DRY RUNWAY
WITHOUT DRAG CHUTE
TIRE LIMIT SPEED
WILL BE EXCEEDED
WITH THESE TAILWINDS
AMBIENT TEMPERATURE ~ °C
AMBIENT TEMPERATURE ~ °F
ZERO WIND ZERO SLOPE GROUND RUN DISTANCE ~ 1000 FT
GROUND RUN DISTANCE WITH WIND, ZERO SLOPE — 1000 FT
Base Line
Base Line
TAKEOFF
LANDING
HEADWIND — KNOTS
TAILWIND — KNOTS
RUNWAY SLOPE — %
FORM 5278A

Figure A2-18

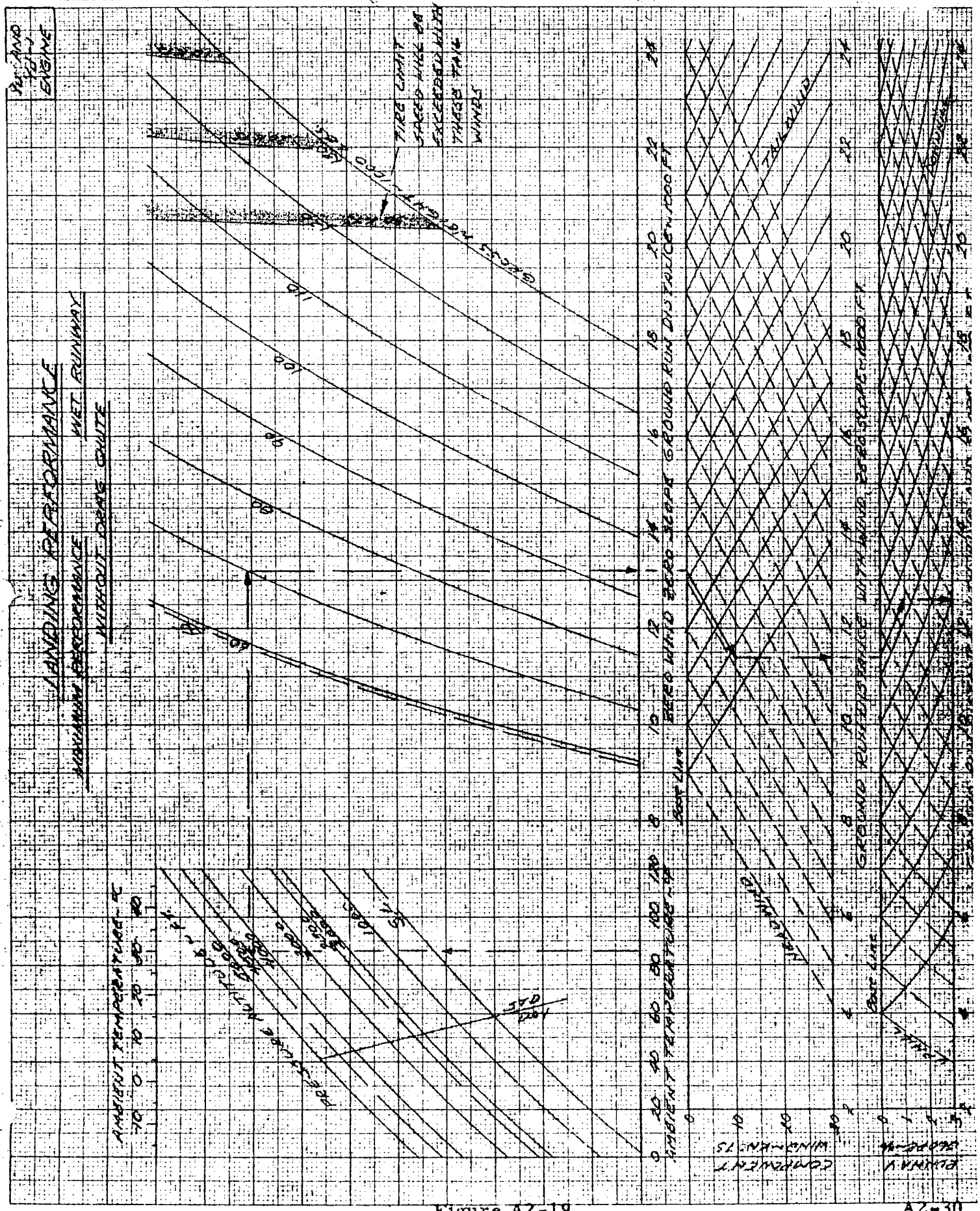


Figure A2-19

PART III

CLIMB AND DESCENT PERFORMANCE

List of Illustrations

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Normal Climb Performance ("MEAN TROPIC" Atmosphere)	
Phase I, Subsonic climb from brake release	A3-7
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Phase II, Transonic Maneuver	A3-9
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NORMAL CLIMB PERFORMANCE

Figures A3-1 through A3-12 present normal performance to cruise altitudes for supersonic operation with 1956 ARDC Atmosphere and "MEAN TROPIC" Atmospheric conditions, respectively. The data is computed from results of Flight Test and Operational Testing with YJ-1 engines. The climb is segmented in three phases and includes the effects of varying gross weights and air temperatures on fuel used, time, and distance. Phase I is the subsonic portion of the climb from brake release at sea level to 38,000 feet and 0.90 Mach. Corrections for time, fuel, and distance are listed in the chart for takeoffs from other field elevations. Phase IA is the subsonic portion of the climb from various refuel altitudes to 38,000 feet and 0.90 Mach. Phase II is the transonic acceleration portion of the climb from 38,000 feet and 0.90 Mach to 30,000 feet and 1.25 Mach utilizing the "dive through" technique. Phase III is the supersonic portion of the climb from 30,000 feet and 1.25 Mach to the altitude at which cruise Mach number is first attained. Phase IIIA is the constant Mach portion of the climb from the end of Phase III to the altitude for start of cruise. The following is a tabulation of the average results of flight tests for Phase IIIA.

Cruise Profile Scheduled	Avg. R/C FPM	Power	Avg. Total Fuel Flow Lb/Min.
Long Range	2500	Cruise	666 (20,000/ PPH/eng)
High Altitude	4000	Max AB	900 (27,000/ PPH/eng)

Example (1):

Obtain the time, distance, and fuel required from brake release for takeoff at a field elevation of 4500 feet to 3.10 Mach and 73,000 feet for a standard day. Fuel load at brake release is 64,000 lb after subtracting ground fuel allowances for normal ground operation. (See Appendix, Part II, for ground allowance computation procedure.) Find the initial gross weight at brake release by adding the zero fuel weight and the fuel load remaining. If the zero fuel weight is 55,150 pounds, the initial gross weight is 119,150 pounds.

Enter figure A3-1 at the initial gross weight at brake release and read fuel used, time and distance for Phase I as 7800 pounds, 6.47 minutes, and 48.6 nautical miles, respectively.

From the table in table in figure A3-1 for the 4500 foot field elevation, reduce time, fuel, and distance by 0.30 minutes, 500 pounds, and 1.6 nautical miles. Therefore, fuel used, time, and distance for Phase I are 7300 lb (7800-500), 6.17 min. (6.47-0.30), and 47.0 nmi (48.6 - 1.6). Recompute the gross weight at the end of Phase I climb as 111,850 pounds (119,150 - 7300). Enter figure A3-3 at the recomputed gross weight and read fuel used, time and distance for Phase II as 1420 pounds, 1.20 minutes and 12.2 nautical miles. Summation of Phase I and Phase II results in the fuel used, time, and distance to the start of Phase III as 8720 pounds (7300 + 1420), 7.37 minutes (6.17 + 1.20), and 59.2 nautical miles (47.0 + 12.2). The recomputed gross weight for entering Phase III will be 110,430 pounds (119,150 - 8720). Enter figure A3-5 with the recomputed gross weight and at 73,000 feet and Mach 3.10, read fuel used, time, and distance for Phase III as 13,500 pounds, 9.9 minutes, and 205.6 nautical miles, respectively. Add all three phases and obtain fuel used, time, and distance

PART III

CLIMB AND DESCENT PERFORMANCE

List of Illustrations

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Normal Descent Performance	A3-17
350 KEAS Descent Performance	A3-18
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NORMAL CLIMB PERFORMANCE

FROM BRAKE RELEASE

Figures A3-1 through A3-5 and A3-7 through A3-11 present normal climb performance from brake release to cruise altitudes for supersonic operation with 1956 ARDC Atmosphere and "MEAN TROPIC" Atmospheric conditions, respectively. The data is computed from results of Flight Test and Operational Testing with YJ-1 engines. The climb is segmented in three phases and includes the effects of varying gross weights and air temperatures on fuel used, time, and distance. Phase I is the subsonic portion of the climb from brake release at sea level to 30,000 feet and 0.90 Mach. Cor-

rections for time, fuel, and distance are listed in the chart for takeoffs from other field elevations. Phase II is the transonic acceleration portion of the climb from 30,000 feet and 0.90 Mach to 30,000 feet and 1.25 Mach utilizing the climb and dive technique. Phase III is the supersonic portion of the climb from 30,000 feet and 1.25 Mach to the altitude at which cruise Mach number is first attained. Phase IIIA is the constant Mach portion of the climb from the end of Phase III to the altitude for start of cruise. The following is a tabulation of the average results of flight tests for Phase IIIA.

Cruise Profile Scheduled	Avg. R/C FPM	Power	Avg. Total Fuel Flow Lb/Min.
Long Range	2500	Cruise	666 (20,000/ PPH/eng)
High Altitude	4000	Max AB	900 (27,000/ PPH/eng)

Example:

Obtain the time, distance, and fuel required from brake release for takeoff at a field elevation of 4500 feet to 3.10 Mach and 73,000 feet for a standard day. Fuel load at brake release is 64,000 lb after subtracting ground fuel allowances for normal ground operation. (See Appendix, Part II, for ground allowance computation procedure.) Find the initial gross weight at brake release by adding the zero fuel weight and the fuel load remaining. If the zero fuel weight is 55,150 pounds, the initial gross weight is 119,150 pounds. Enter figure A3-1 at the initial gross weight at brake release and read fuel used, time and distance for Phase I as 6150 pounds, 4.8 minutes, and 34 nautical miles, respectively.

From the table in figure A3-1, for the 4500 foot field elevation, reduce time, fuel, and distance by 0.30 minutes, 500 lb, and 1.6 nmi, respectively. Therefore, fuel used, time, and distance for Phase I is 5650 lb (6150-500), 4.5 min. (4.8 - 0.3), and 32.4 nmi (34 - 1.6), respectively. Recompute the gross weight at end of climb Phase I as 113,500 pounds (119,150 - 5650). Enter figure A3-2 as the recomputed gross weight and read fuel used, time, and distance for Phase II as 3100 pounds, 2.9 minutes, and 27 nautical miles, respectively. Recompute the gross weight at end of Phase II as 110,400 pounds (113,500 - 3100). Enter figure A3-4 with the recomputed gross weight and at 73,000 feet and Mach 3.10, read fuel used, time, and distance for Phase III as 13,500 pounds, 9.9 minutes, and 205.6 nautical miles, respectively. Add all three phases and obtain fuel used, time, and distance as 22,250 pounds, 17.3 minutes, and 265 nautical miles, respectively. Fuel remaining at 73,000 feet is 41,750 pounds (64,000 - 22,250).

Service allowances and/or allowances for deviations from the normal climb schedule can be applied to an affected phase when required. (For example, a subsonic cruise operation prior to reaccelerating might be scheduled in the flight plan.) The effect of such an allowance must be accounted for when computing the initial weight to be used for the next phase of the climb.

AFTER AIR REFUELING

Figures A3-6 and A3-12 present normal climb performance from the end of 30,000 foot refuel (refueling with one AB on) to the altitudes at which cruise Mach number is reached for 1956 ARDC Atmosphere and "MEAN TROPIC" Atmospheric conditions, respectively. Adjustments which should be used for other end A/R altitudes are listed in the charts. The data is computed from Flight Test and Operational Testing results with YJ-1 engines. The assumed fuel load at the end of A/R is 67,300 lb. Phase IIIA results are identical to the tabulation in the previous discussion.

PHASE III CLIMB WITH TURNS

Turns during climb are not recommended, however, if mission requirements include a turn, compensation for range lost due to the turn must be included in the flight plan. For example, consider a 45° heading change with a 30° bank at an initial altitude of 45,000 feet.

To minimize the rate of climb loss due to turning, the recommended procedure is to advance power to Maximum A/B during the turn and maintain the speed schedule of 450 KEAS. Resume the normal climb procedure on completion of the turn.

Comparison of straightaway climb and turning climb on time, fuel and distance results in an overall range loss of 32 miles for a Mach 3.20 profile. On completion of the 45° turn, at 49,000 feet; time, fuel and distance to that altitude will be 0.35 min, 730 lb, and 6.4 mi greater than for a normal climb with no turn.

MILITARY THRUST CLIMB PERFORMANCE

Figures A3-13 thru A3-16 present Military climb performance for a schedule of 300 knots equivalent airspeed (KEAS) while below 33,300 feet and 0.90 Mach number when higher altitudes are attained. This power and speed schedule provides the most climb distance for the fuel consumed when subsonic cruising flight plans, such as for ferry or buddy missions, are used.

Example (1):

Find the time, distance and fuel required to climb to 30,000 feet from S. L. on a std -10°C day with an initial gross weight of 105,000 lb. Enter figure A3-13 at 30,000 ft, and at 105,000 lb initial gross weight read 8.5 min, 56.6 miles and 4200 lbs. Adding takeoff allowances results in time, distance and fuel values of 9.4 min. (8.5 + 0.9), 59.2 miles (56.6 + 2.6) and 6000 lb (4200 + 1800) for climb from sea level to 30,000 feet.

Example (2):

Find the time, distance and fuel required to climb to 30,000 feet from 4500 foot takeoff on a std day with an initial gross weight of 105,000 pounds. Enter figure A3-14 at 4500 feet and at 105,000 pound initial gross weight; read 0.4 min, 3.8 miles and 550 pounds. Reenter figure A3-14 at 30,000 feet and an adjusted initial gross weight of 105,550 pounds; read 8.6 min, 58.0 miles and 4300 pounds. Adding takeoff allowances and subtracting values for climb from sea level to 4500 feet results in time, distance and fuel values of 9.1 min (8.6 + .9 - .4), 56.8 miles (58.0 + 2.6 - 3.8) and 5550 pounds (4300 + 1800 - 550) for climb from takeoff at 4500 to 30,000 feet.

TWO ENGINE DESCENT PERFORMANCE

On course descent performance is shown on figures A3-17, A3-18, and A3-19. Figure A3-17 presents descent performance for the normal 300 KEAS schedule. Figures A3-18 and A3-19 present 350 KEAS descent performance with forward bypass doors in the automatic and open positions respectively.

SINGLE ENGINE DESCENT PERFORMANCE

Figures A3-20 through A3-24 present single engine descent performance from 80,000 feet and Mach 3.10 (337 KEAS). The data is based on flight test with the inlet configuration as listed in the charts. Time, distance, and fuel required are plotted versus altitude. A pushover at constant Mach is required to increase airspeed from 337 KEAS to the 350 KEAS or 400 KEAS schedule. Better range is obtained when the 300 KEAS schedule is used, reducing airspeed to 300 KEAS while maintaining constant altitude. These effects are in-

cluded in the performance data. Specific range begins to decrease rapidly near 50,000 feet; therefore, the charts are indexed to an altitude of 50,000 feet so that a power reduction technique can be used and the resultant change in performance can be determined. The effect of changing KEAS at the indexed 50,000 feet has not been defined by flight testing and is not included in the data.

Figure A3-20 summarizes the effect of airspeed on Maximum AB descent performance for constant values of 300, 350, and 400 KEAS. Figures A3-21 through A3-23 present the effects of decreasing power at the index altitude of 50,000 feet for constant airspeeds of 300, 350, and 400 KEAS, respectively. Figure A3-24 presents the effects of a 180° turn at 35° bank angle on a 350 KEAS descent. Approximately 23,000 feet of altitude is required to complete the 180° turn. For convenience in mission planning, a ground track profile is also provided.

Example (1):

Find the time, distance, and fuel required to descend on course from 80,000 feet and Mach 3.10 using the 300 KEAS descent schedule and Minimum AB below 50,000 feet. Enter figure A3-21 at 80,000 feet and read the time, distance, and fuel required to 50,000 feet as 8.6 minutes, 176 nautical miles, and 2800 pounds of fuel. Reenter at the final altitude of 31,500 feet on the Minimum AB line and read time, distance, and fuel required as 5 minutes, 52 nautical miles and 1600 lb of fuel. Add the results and obtain 13.6 minutes, 228 nautical miles, and 4400 pounds of fuel.

Example (2):

Find the track time, distance, and fuel required to descend from 80,000 feet and Mach 3.10 using the 350 KEAS descent schedule. A 90° turn is to be completed above 50,000 feet, and Minimum AB is to be used below 50,000 feet. Enter figure A3-24 and note on the penetration distance curve that 90° of turn is completed at 65,000 feet altitude. Read time at that altitude as 3.0 minutes and fuel used as 1200 pounds. On the ground track profile note that the distance traveled is 80 nautical miles. Enter figure A3-22 at 65,000 feet (end of turn altitude) and read time, distance, and fuel required to 50,000 feet as 4.1 minutes, 73 nautical miles, and 1950 pounds. Reenter at the final altitude of 28,000 feet on the Minimum AB line and read time, distance, and fuel required as 3.4 minutes, 41 nautical miles and 1200 lb of fuel. Add the incremental readings and obtain 10.5 minutes, 194 nautical miles, and 4350 pounds of fuel.

as 22,200 pounds, 17.3 minutes, and 265 nautical miles, respectively. Fuel remaining at 73,000 feet is 41,800 pounds (64,000 - 22,200).

Service allowances and/or allowances for deviations from the normal climb schedule can be applied to an affected phase when required. (For example, a subsonic cruise operation prior to reaccelerating might be schedule in the flight plan.) The effect of such an allowance must be accounted for when computing the initial weight to be used for the next phase of the climb.

Example (2):

Obtain the MEAN TROPIC day time, distance, and fuel required from refuel at 29,000 feet to 0.90 Mach at 38,000 feet (start of Phase II). Enter fig. A3-8 at 29,000 feet and read fuel used, time, and distance for Phase IA as 3740 pounds, 3.60 minutes, and 31.6 nautical miles, respectively. The recomputed gross weight for entering Phase II will be 118,710 pounds (122,450 - 3740).

PHASE III CLIMB WITH TURNS

Turns during climb are not recommended, however, if mission requirements include a turn, compensation for range lost due to the turn must be included in the flight plan. For example, consider a 45° heading change with a 30° bank at an initial altitude of 45,000 feet.

To minimize the rate of climb loss due to turning, the recommended procedure is to advance power to Maximum A/B during the turn and maintain the speed schedule of 450 KEAS. Resume the normal climb procedure on completion of the turn.

Comparison of straightaway climb and turning climb on time, fuel and distance results in an overall range loss of 32 miles for a Mach 3.20 profile. On completion of the 45° turn, at 49,000 feet; time, fuel and distance to that altitude will be 0.35 min, 730 lb, and 6.4 mi greater than for a normal climb with no turn.

MILITARY THRUST CLIMB PERFORMANCE

Figures A3-13 thru A3-16 present Military climb performance for a schedule of 300 knots equivalent airspeed (KEAS) while below 33,300 feet and 0.90 Mach number when higher altitudes are attained. This power and speed schedule provides the most climb distance for the fuel consumed when subsonic cruising flight plans, such as for ferry or buddy missions, are used.

Example (1):

Find the time, distance and fuel required to climb to 30,000 feet from S.L. on a std -10°C day with an initial gross weight of 105,000 lb. Enter figure A3-13 at 30,000 ft, and at 105,000 lb initial gross weight read 8.5 min, 56.6 miles and 4200 lbs. Adding takeoff allowances results in time, distance and fuel values of 9.4 min. (8.5 + 0.9), 59.2 miles (56.6 + 2.6) and 6000 lb (4200 + 1800) for climb from sea level to 30,000 feet.

Example (2):

Find the time, distance and fuel required to climb to 30,000 feet from 4500 foot takeoff on a std day with an initial gross weight of 105,000 pounds. Enter figure A3-14 at 4500 feet and at 105,000 pound initial gross weight; read 0.4 min, 3.8 miles and 550 pounds. Reenter figure A3-14 at 30,000 feet and an adjusted initial gross weight of 105,550 pounds; read 8.6 min, 58.0 miles and 4300 pounds. Adding takeoff allowances and subtracting values for climb from sea level to 4500 feet results in time, distance and fuel values of 9.1 min (8.6 + .9 - .4), 56.8 miles (58.0 + 2.6 - 3.8) and 5550 pounds (4300 + 1800 - 550) for climb from takeoff at 4500 to 30,000 feet.

TWO ENGINE DESCENT PERFORMANCE

On course descent performance is shown on figures A3-17, A3-18, and A3-19. Figure A3-17 presents descent performance for the normal 300 KEAS schedule. Figures A3-18 and A3-19 present 350 KEAS descent performance with forward bypass doors in the automatic and open positions respectively.

SINGLE ENGINE DESCENT PERFORMANCE

Single Engine Descent data is presented for Military, Minimum afterburning and Maximum afterburning power at 300, 350 and 400 KEAS with 1956 ARDC and Mean Tropic Atmosphere conditions. Refer to figures A3-20 through A3-23B.

Allowances For Deceleration To Descent Speed:

When cruising at a higher KEAS than the desired descent schedule, the constant altitude deceleration is made at the same power setting as the constant KEAS descent. The constant Mach lines show the beginning point of the deceleration for each Mach number. In the situation where the cruise KEAS is less than the desired descent KEAS, the constant Mach descent is made with Maximum afterburning power. The constant Mach lines show the descent for different Mach numbers.

Comparison Of Descent Power and Speed Schedules:

The Maximum afterburning descent, as compared to the Minimum afterburning and Military power descents, results in a longer distance, a longer elapsed time and more fuel used. The 400 KEAS descent as compared to the 350 and 300 KEAS descents results in a slightly longer distance, less elapsed time and more fuel used. Maximum overall range results if a descent speed of 300 KEAS is used and if Military power is used in the descent and for cruise. There will be little overall range loss if either Minimum afterburning or Maximum afterburning descent power is used as long as the cruise is accomplished in Military power. The charts are indexed to an altitude of 50,000 feet so that a technique of power or airspeed change can be used and the resultant effect after power change in performance can be determined. The effect of changing KEAS at the indexed 50,000 feet has not been defined by flight testing and is not included in the data.

CAUTION

When making a single engine descent with the operating engine in Military power, the Mach rate limit of 1.0 Mach in three minutes will be exceeded.

Single Engine Turning Descent

Figure A3-24 presents the effects of a 180° turn at 35° bank angle on a 350 KEAS descent. Approximately 23,000 feet of altitude is required to complete the 180° turn. For convenience in mission planning, a ground track profile is also provided.

Sample Use Of Charts

Example (1):

Find distance, time and fuel to descend from 80,000 feet to 29,000 feet, using Minimum afterburning power and 300 KEAS. Initial speed is Mach 3.1 (337 KEAS). Normal (ARDC Standard) atmosphere conditions are expected. Refer to Figure A3-20. Enter the chart at 80,000 feet and located the Minimum afterburning line for the 3.1 Mach, (337 KEAS) condition, and read distance, time and fuel to 50,000 feet.

Distance = 137 miles

Time = 6.8 minutes

Fuel = 1200 pounds

Enter the same chart at 29,000 feet and read distance, time and fuel from 50,000 feet to 29,000 feet.

Distance = 75 miles

Time = 8.5 minutes

Fuel = 2400 pounds

Add the above values to obtain distance time and fuel from 80,000 feet and 3.1 Mach to 29,000 feet in Minimum afterburning at 300 KEAS.

Distance = 212 miles

Time = 15.3 minutes

Fuel = 3600 pounds

Example (2):

Find the track time, distance, and fuel required to descend from 80,000 feet and Mach 3.10 using the 350 KEAS descent schedule. A 90° turn is to be completed above 50,000 feet, and Minimum AB is to be used below 50,000 feet. Enter figure A3-24 and note on the penetration distance curve that 90° of turn is completed at 65,000 feet altitude. Read time at that altitude as 3.0 minutes and fuel used as 1200 pounds. On the ground track profile note that the distance traveled is 80 nautical miles. Enter figure A3-21 at 65,000 feet (end of turn altitude) and read time, distance, and fuel required to 50,000 feet as 4.1 minutes, 73 nautical miles, and 1950 pounds. Reenter at the final altitude of 28,000 feet on the Minimum AB line and read time, distance, and fuel required as 3.4 minutes, 41 nautical miles and 1200 lb of fuel. Add the incremental readings and obtain 10.5 minutes, 194 nautical miles, and 4350 pounds of fuel.

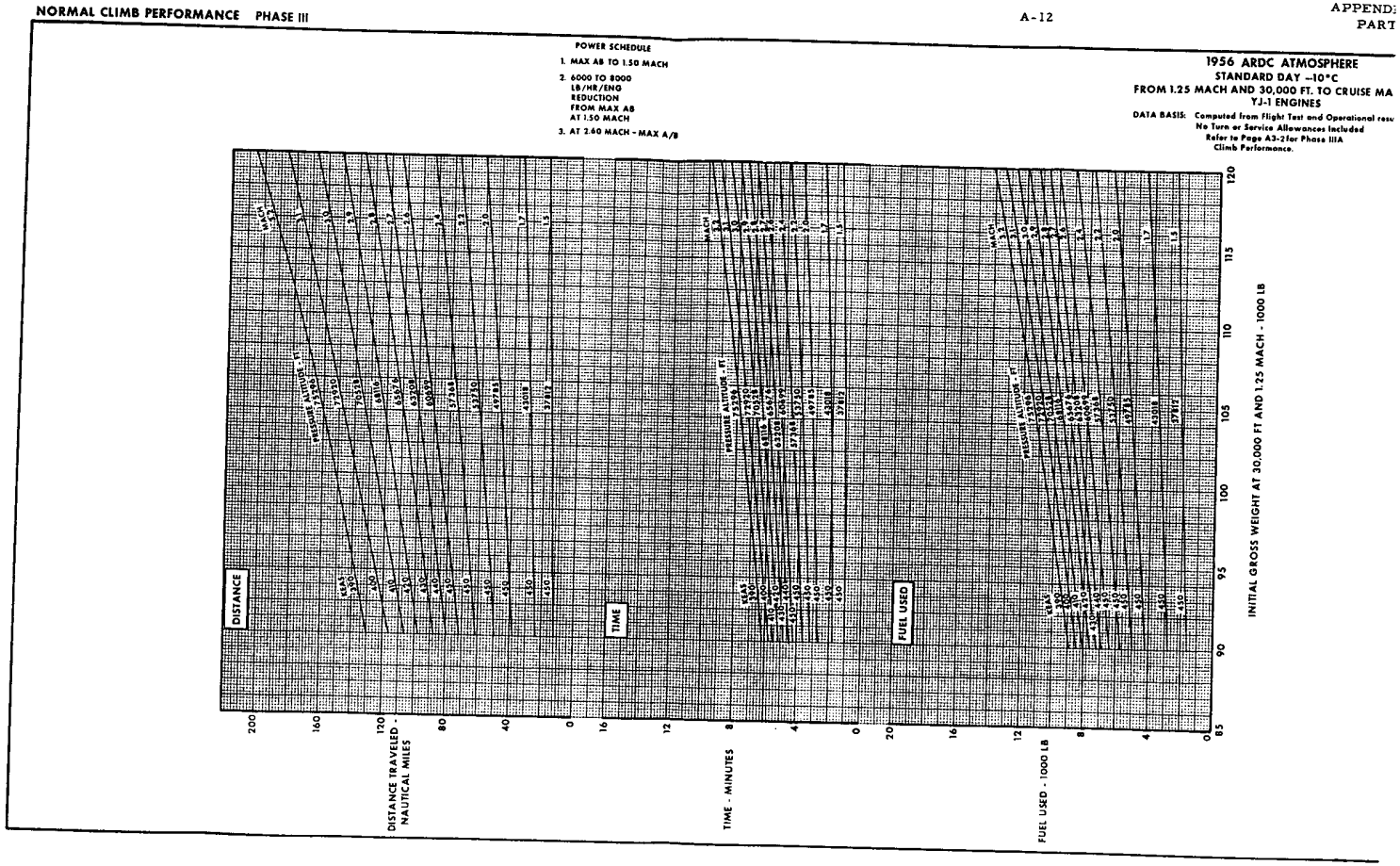
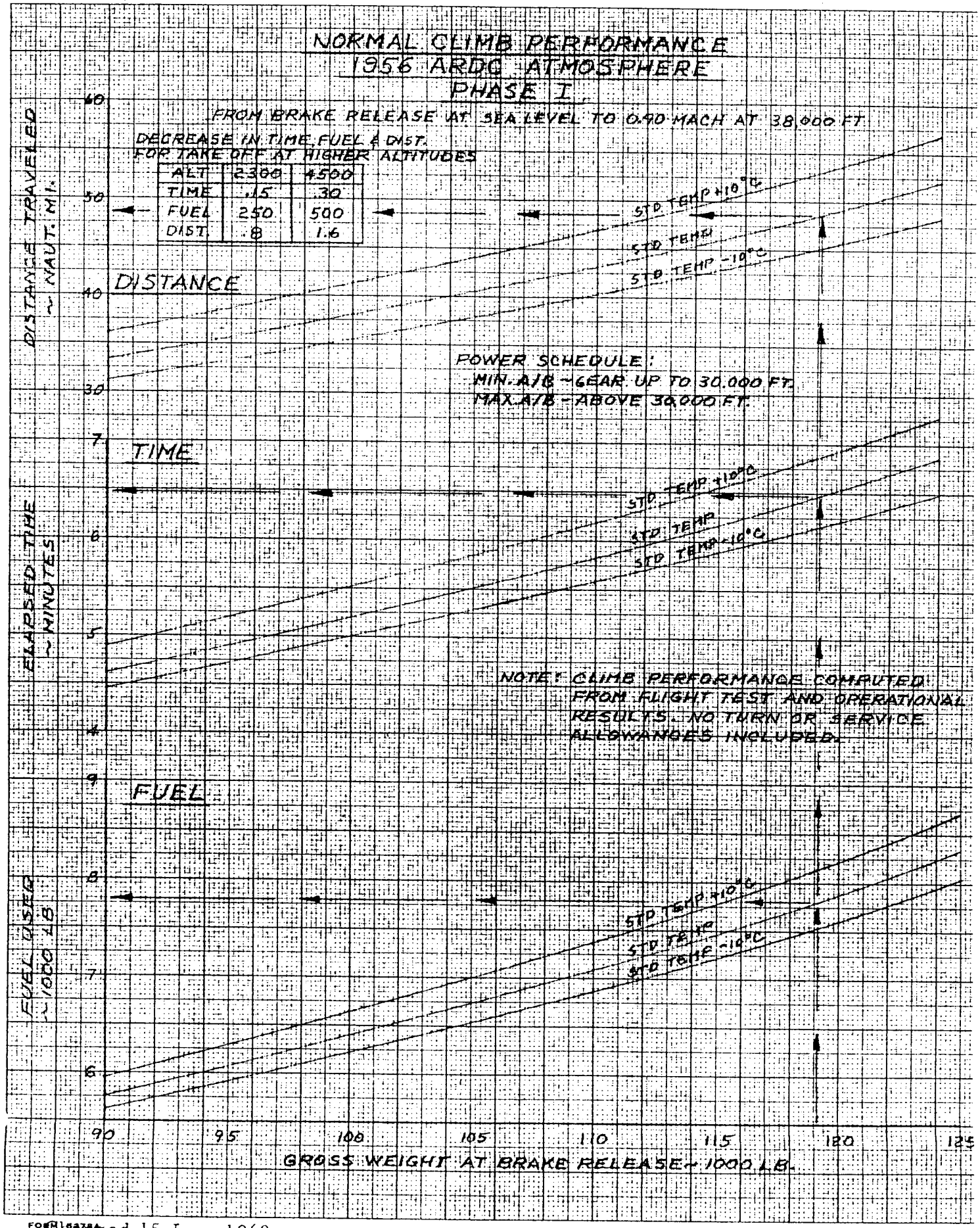

POWER SCHEDULE
1. MAX AB TO 1.50 MACH
2. 6000 TO 8000 LB/HR/ENG REDUCTION FROM MAX AB AT 1.50 MACH
3. AT 2.60 MACH - MAX A/B
1956 ARDC ATMOSPHERE
STANDARD DAY -10°C
FROM 1.25 MACH AND 30,000 FT. TO CRUISE MA
YJ-1 ENGINES
DATA BASIS: Computed from Flight Test and Operational resu
No Turn or Service Allowances Included
Refer to Page A3-2for Phase IIIA Climb Performance.
DISTANCE
TIME
FUEL USED
DISTANCE TRAVELED - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
INITIAL GROSS WEIGHT AT 30,000 FT AND 1.25 MACH - 1000 LB

Figure A3-4


NORMAL CLIMB PERFORMANCE
1956 ARDC ATMOSPHERE
PHASE I
FROM BRAKE RELEASE AT SEA LEVEL TO 0.90 MACH AT 38,000 FT
DECREASE IN TIME, FUEL & DIST.
FOR TAKE OFF AT HIGHER ALTITUDES
ALT 2300 4500
TIME .15 .30
FUEL 250 500
DIST .8 1.6
DISTANCE
STD TEMP +10°C
STD TEMP
STD TEMP -10°C
POWER SCHEDULE:
MIN. A/B - GEAR UP TO 30,000 FT.
MAX. A/B - ABOVE 30,000 FT.
TIME
NOTE: CLIMB PERFORMANCE COMPUTED FROM FLIGHT TEST AND OPERATIONAL RESULTS. NO TURN OR SERVICE ALLOWANCES INCLUDED.
FUEL
DISTANCE TRAVELED ~ NAUT. MI.
ELAPSED TIME ~ MINUTES
FUEL USED ~ 1000 LB
GROSS WEIGHT AT BRAKE RELEASE ~ 1000 LB.

NORMAL CLIMB PERFORMANCE PHASE I

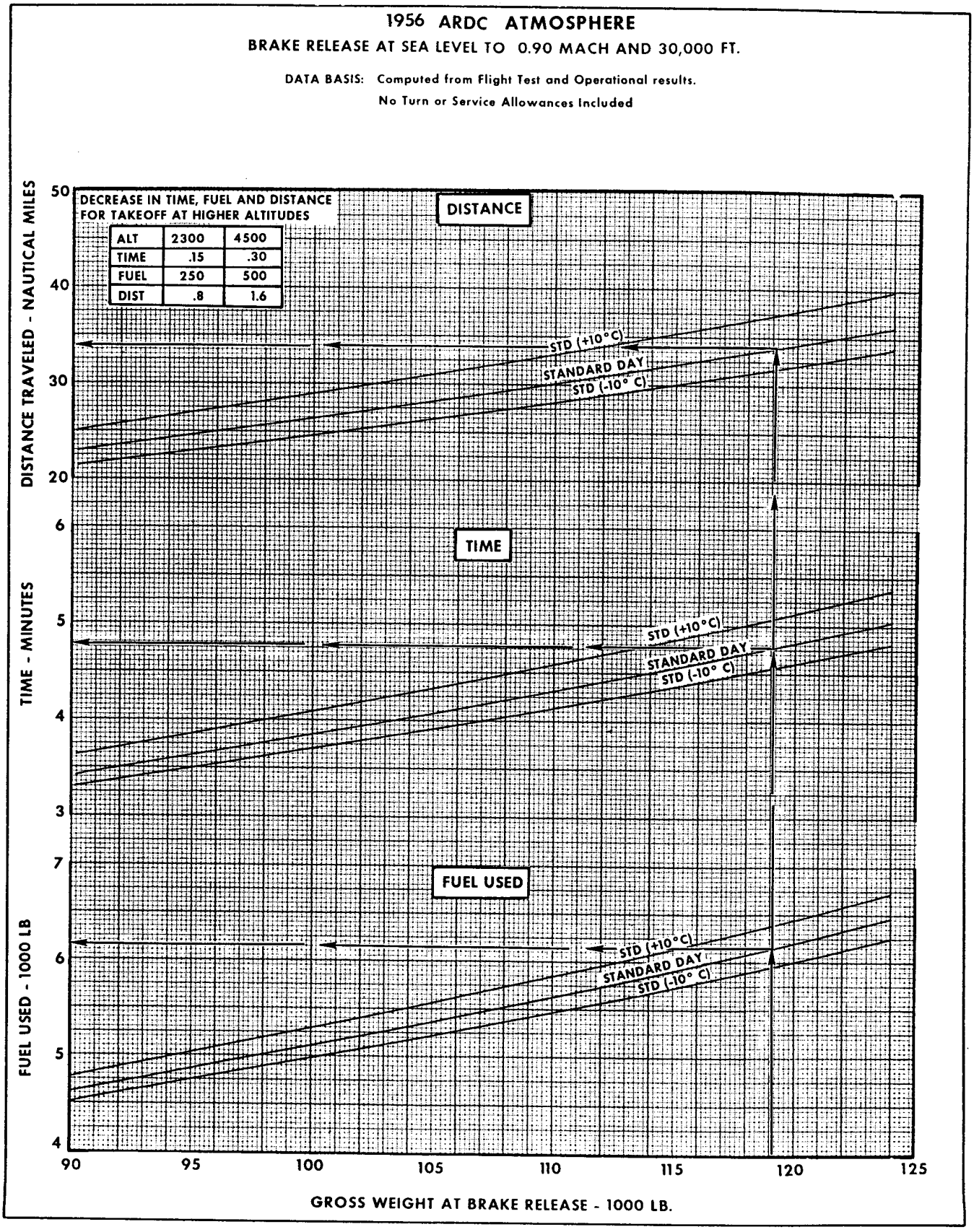


Figure A3-1

NORMAL CLIMB PERFORMANCE PHASE II

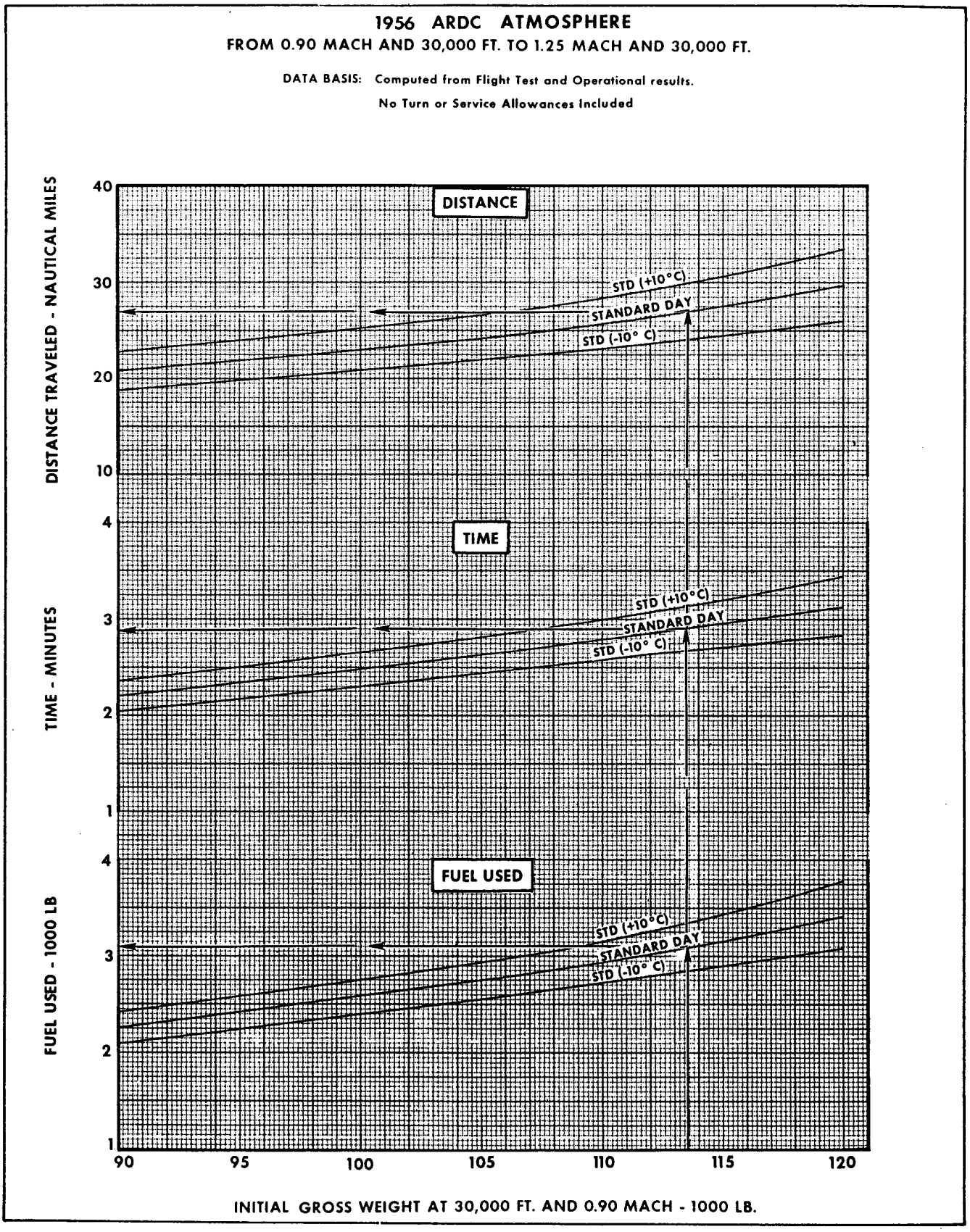
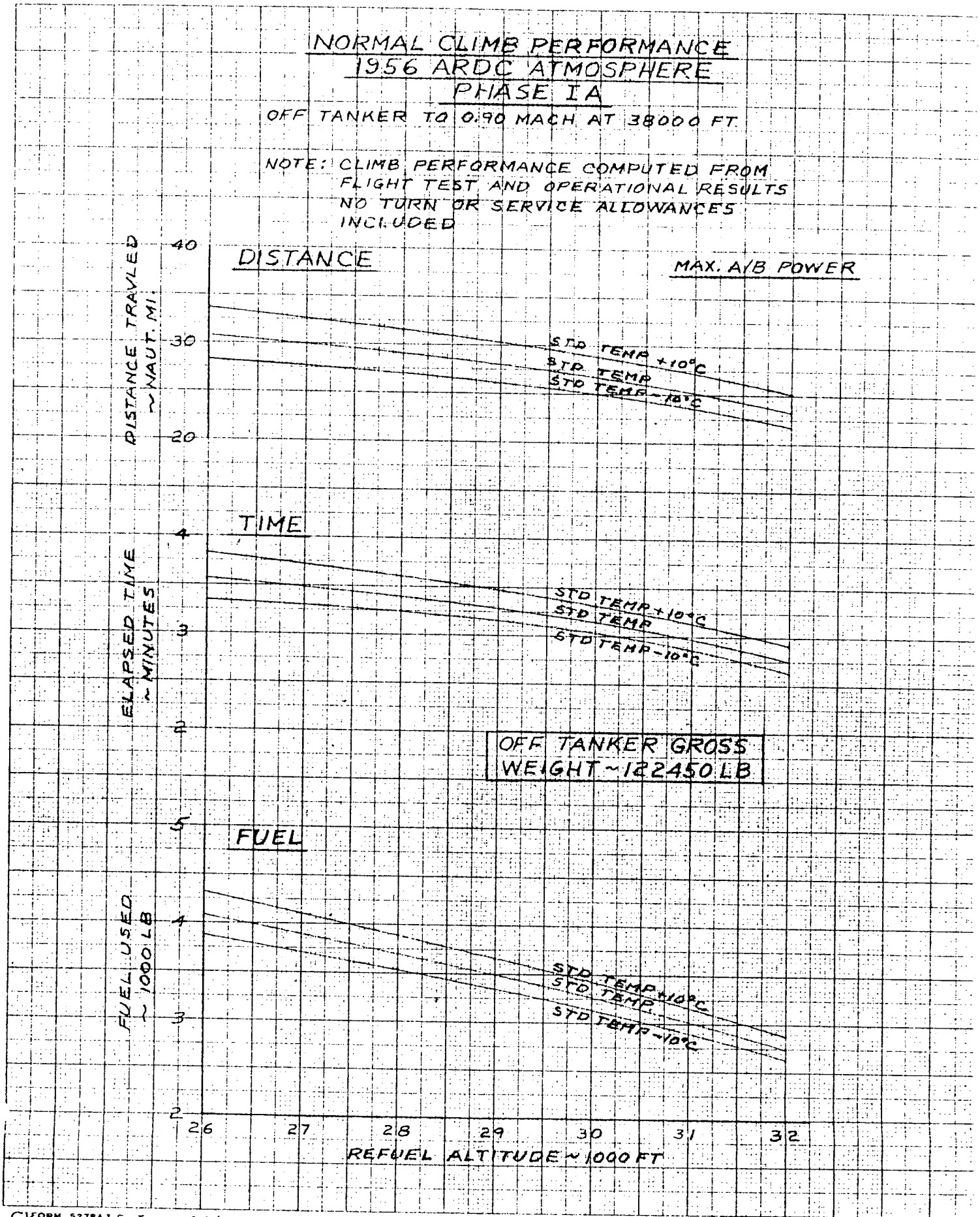


Figure A3-2



BLUEPRINT CHARTS

NORMAL CLIMB PERFORMANCE
1956 ARDC ATMOSPHERE
PHASE II

FROM 0.90 MACH & 38,000 FT TO 1.25 MACH & 30,000 FT.

NOTE: CLIMB PERFORMANCE COMPUTED FROM FLIGHT TEST AND OPERATIONAL RESULTS. NO TURN OR SERVICE ALLOWANCES INCLUDED.

MAX. A/B POWER

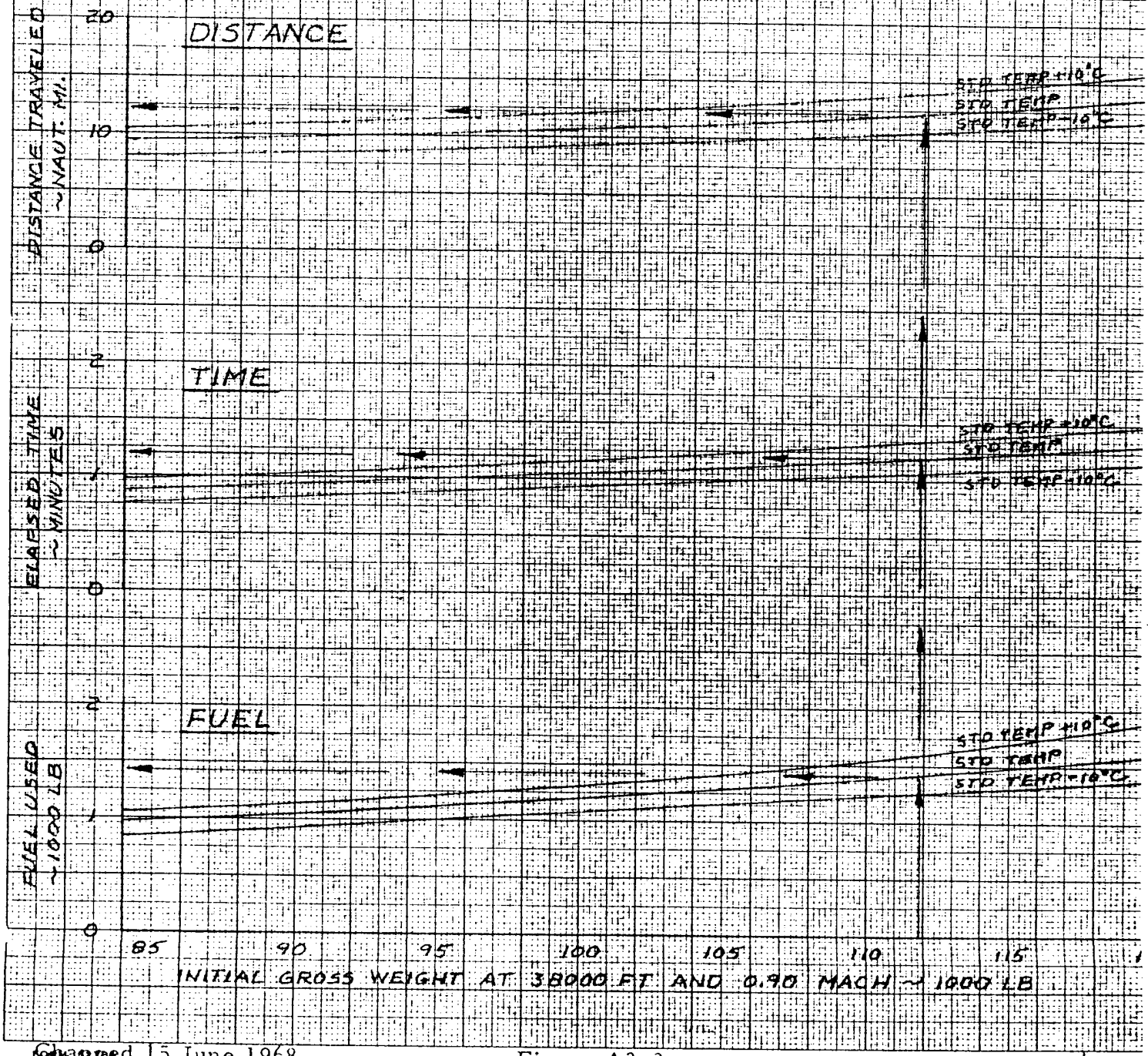


Figure A3-3

NORMAL CLIMB PERFORMANCE PHASE III

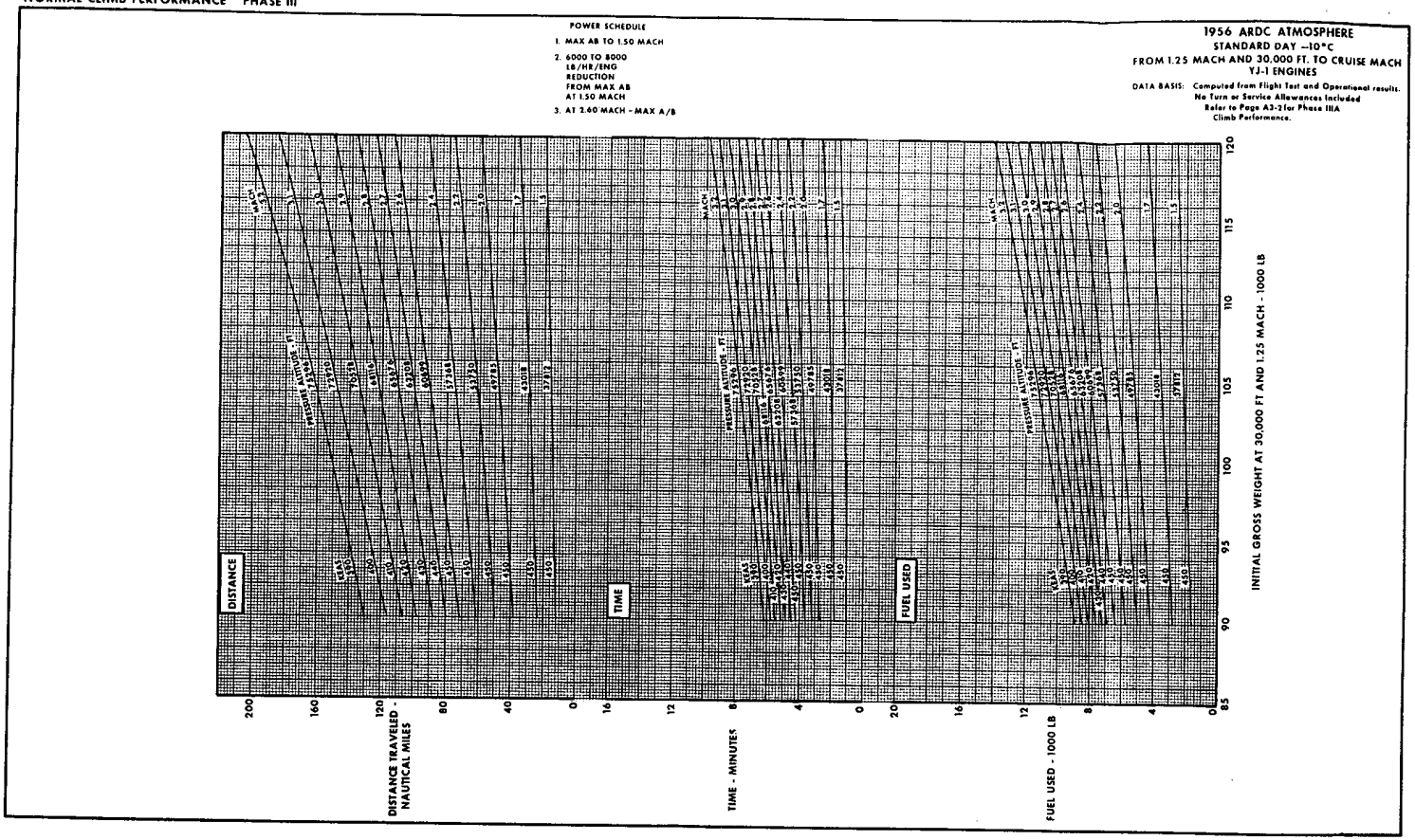

POWER SCHEDULE
1. MAX AB TO 1.50 MACH
2. 6000 TO 8000 LB/HR/ENG REDUCTION FROM MAX AB AT 1.50 MACH
3. AT 2.60 MACH - MAX A/B
1956 ARDC ATMOSPHERE
STANDARD DAY -10°C
FROM 1.25 MACH AND 30,000 FT. TO CRUISE MACH
YJ-1 ENGINES
DATA BASIS: Computed from Flight Test and Operational results. No Turn or Service Allowances Included Refer to Page A3-2 for Phase IIIA Climb Performance.
DISTANCE
TIME
FUEL USED
DISTANCE TRAVELED - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
INITIAL GROSS WEIGHT AT 30,000 FT AND 1.25 MACH - 1000 LB

Figure A3-3

Changed 15 March 1968

NORMAL CLIMB PERFORMANCE PHASE III

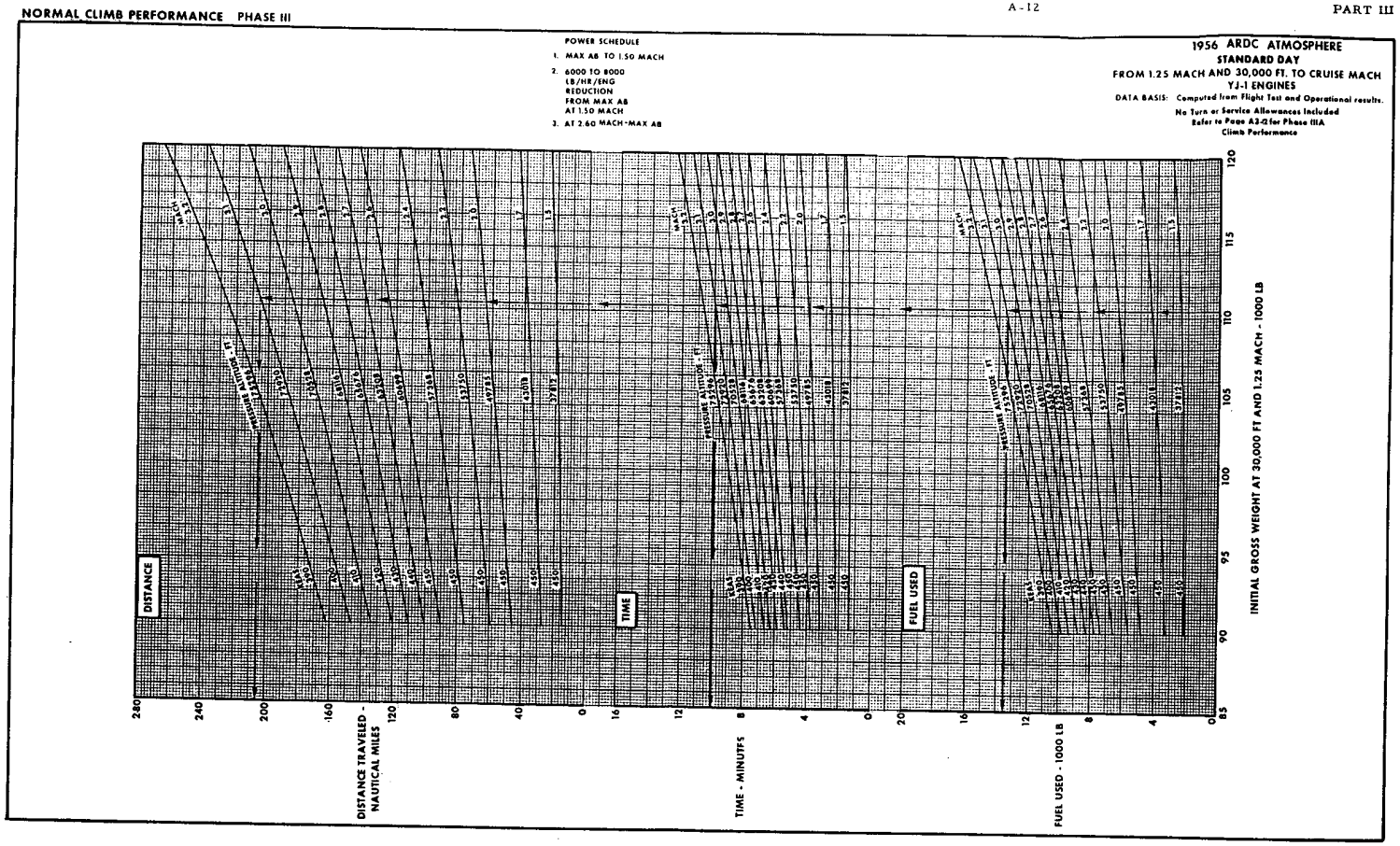

POWER SCHEDULE
1. MAX AB TO 1.50 MACH
2. 6000 TO 8000 LB/HR/ENG REDUCTION FROM MAX AB AT 1.50 MACH
3. AT 2.60 MACH-MAX AB
1956 ARDC ATMOSPHERE
STANDARD DAY
FROM 1.25 MACH AND 30,000 FT. TO CRUISE MACH
YJ-1 ENGINES
DATA BASIS: Computed from Flight Test and Operational results.
No Turn or Service Allowances Included
Refer to Page A3-6 for Phase IIA Climb Performance
DISTANCE
TIME
FUEL USED
DISTANCE TRAVELED - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
INITIAL GROSS WEIGHT AT 30,000 FT AND 1.25 MACH - 1000 LB

Figure A3-4

Changed 15 March 1968

NORMAL CLIMB PERFORMANCE PHASE III

POWER SCHEDULE

1. MAX AB TO 1.50 MACH
2. 6000 TO 8000 LB/HR/ENG REDUCTION FROM MAX AB AT 1.50 MACH
3. AT 2.60 MACH - MAX A/B

MEAN TROPIC ATMOSPHERE
MEAN TROPIC DAY —10°C
FROM 1.25 MACH AND 30,000 FT. TO CRUISE MA
YJ-1 ENGINES

DATA BASIS: Computed from Flight Test and Operational resu
No Turn or Service Allowances Included
Refer to Page A3-2for Phase IIIA
Climb Performance

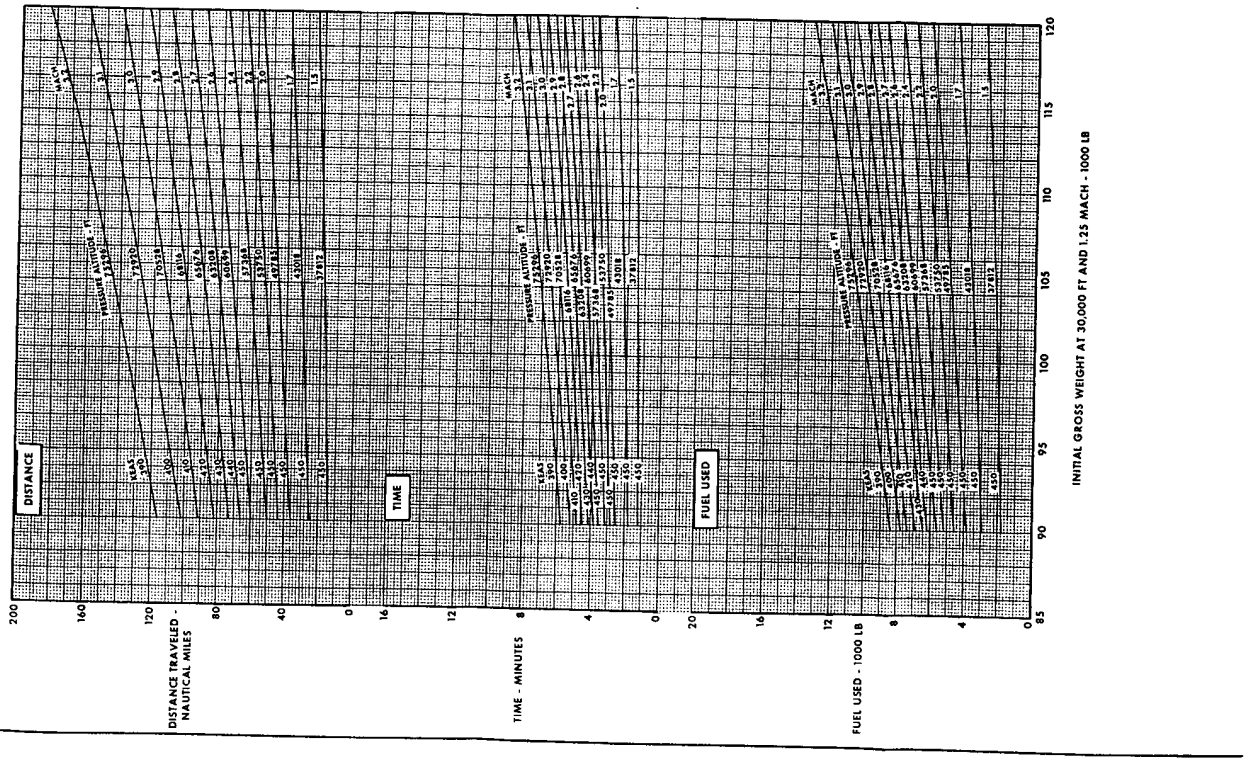

DISTANCE
TIME
FUEL USED
DISTANCE TRAVELED - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
INITIAL GROSS WEIGHT AT 30,000 FT AND 1.25 MACH - 1000 LB

Figure A3-10

NORMAL CLIMB PERFORMANCE PHASE III

POWER SCHEDULE

1. MAX AB TO 1.50 MACH
2. 6000 TO 8000 LB/HR/ENG REDUCTION FROM MAX AB AT 1.50 MACH
3. AT 2.60 MACH-MAX AB

1956 ARDC ATMOSPHERE
STANDARD DAY
FROM 1.25 MACH AND 30,000 FT. TO CRUISE MACH
YJ-1 ENGINES

DATA BASIS: Computed from Flight Test and Operational result

No Turn or Service Allowances Included

Refer to Page A3-2 for Phase IIIA Climb Performance

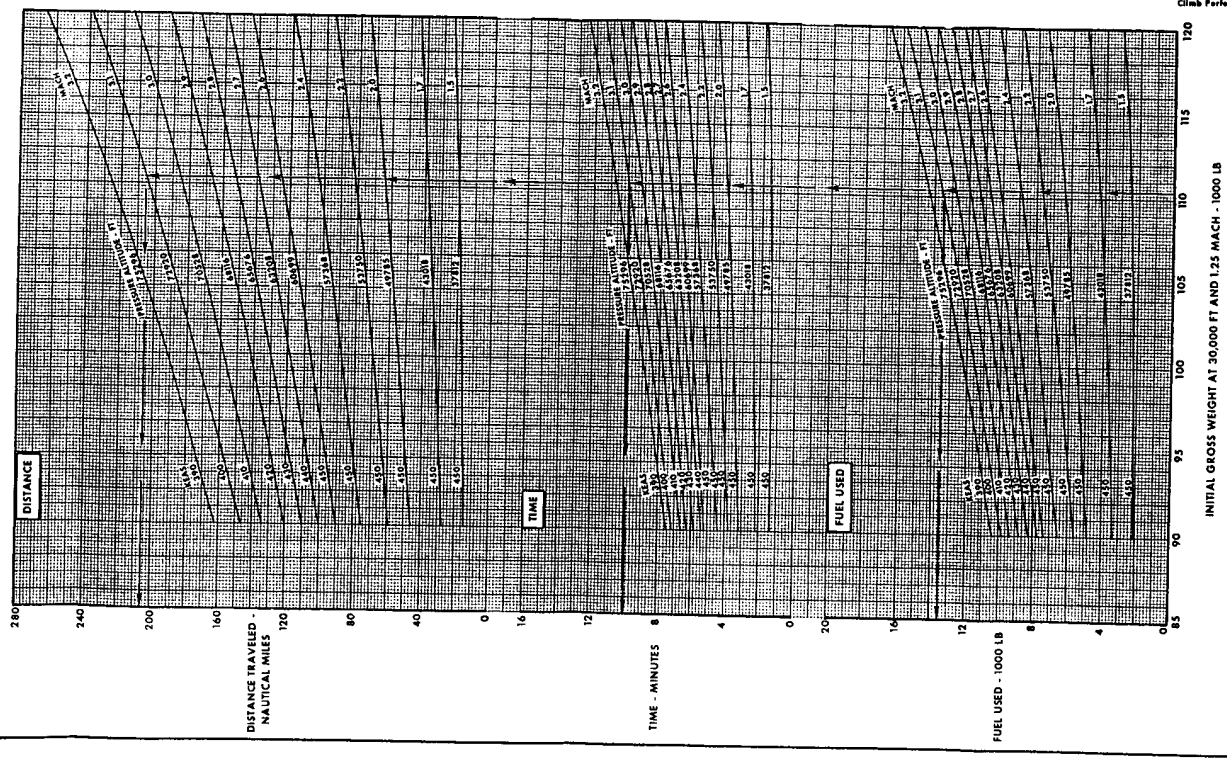

DISTANCE
TIME
FUEL USED
DISTANCE TRAVELED - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
INITIAL GROSS WEIGHT AT 30,000 FT AND 1.25 MACH - 1000 LB

Figure A3-5

NORMAL CLIMB PERFORMANCE PHASE III

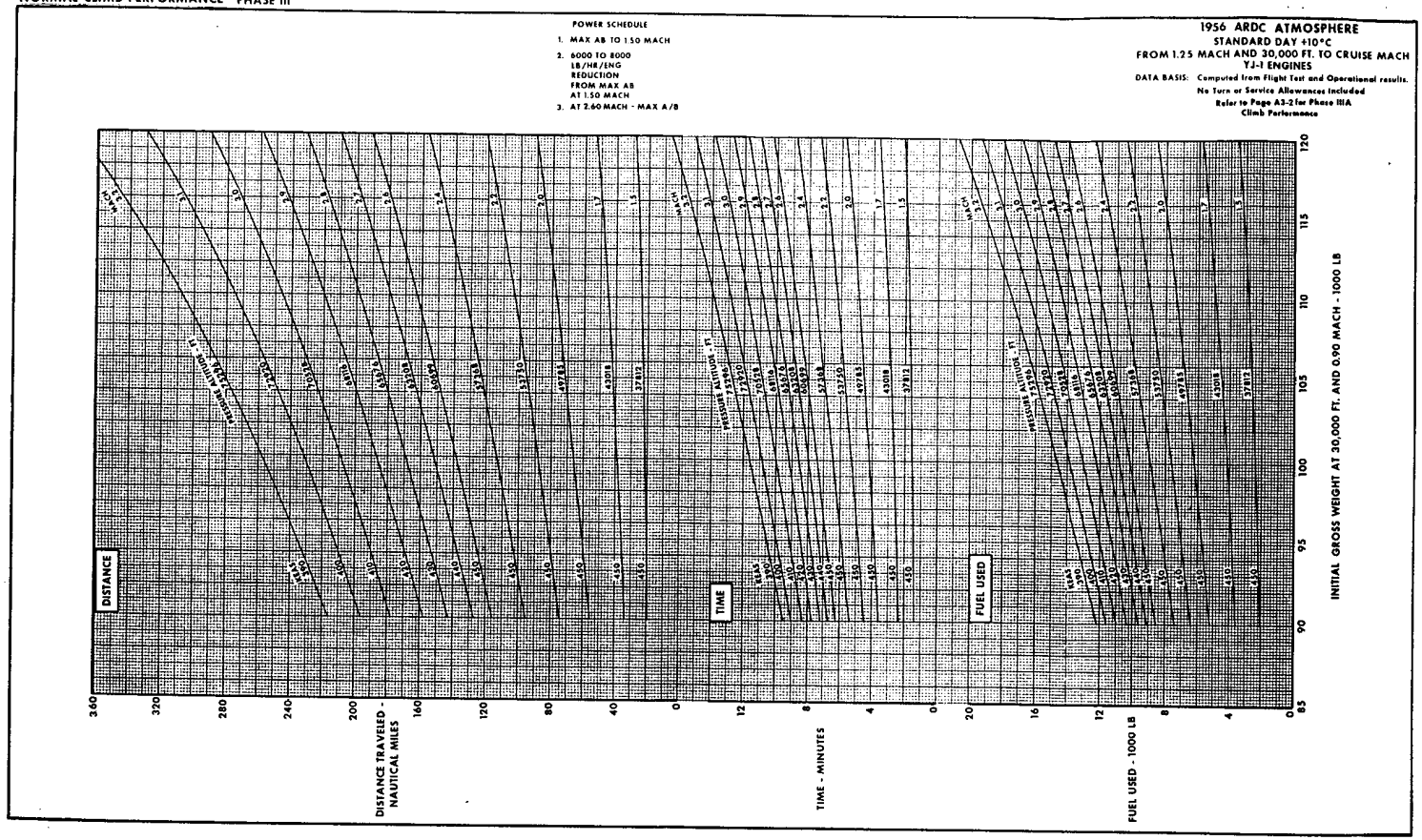

POWER SCHEDULE
1. MAX AB TO 1.50 MACH
2. 6000 TO 8000 LB/HR/ENG REDUCTION FROM MAX AB AT 1.50 MACH
3. AT 2.60 MACH - MAX A/B
1956 ARDC ATMOSPHERE
STANDARD DAY +10°C
FROM 1.25 MACH AND 30,000 FT. TO CRUISE MACH
YJ-1 ENGINES
DATA BASIS: Computed from Flight Test and Operational results.
No Turn or Service Allowances Included
Refer to Page A3-2 for Phase IIIA Climb Performance
DISTANCE
TIME
FUEL USED
DISTANCE TRAVELED - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
INITIAL GROSS WEIGHT AT 30,000 FT. AND 0.90 MACH - 1000 LB

Figure A3-5

Changed 15 March 1968

NORMAL CLIMB PERFORMANCE PHASE III

POWER SCHEDULE

1. MAX AB TO 1.50 MACH
2. 6000 TO 8000 LB/HR/ENG REDUCTION FROM MAX AB AT 1.50 MACH
3. AT 2.60 MACH - MAX A/B

1956 ARDC ATMOSPHERE
STANDARD DAY +10°C
FROM 1.25 MACH AND 30,000 FT. TO CRUISE MA
YJ-1 ENGINES

DATA BASIS: Computed from Flight Test and Operational resu
No Turn or Service Allowances Included
Refer to Page A2-2 for Phase IIIA Climb Performance

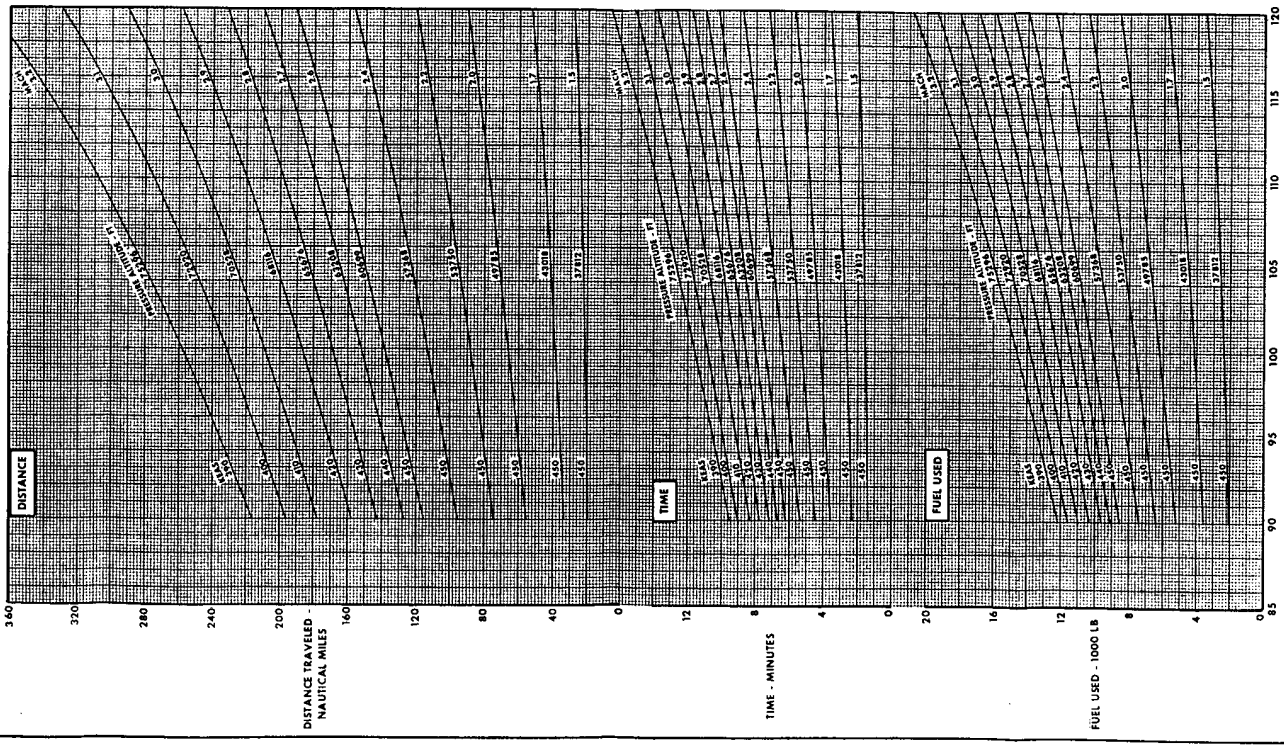

DISTANCE
TIME
FUEL USED
DISTANCE TRAVELED - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
INITIAL GROSS WEIGHT AT 30,000 FT. AND 0.90 MACH - 1000 LB

Figure A3-6

NORMAL CLIMB PERFORMANCE PHASE III

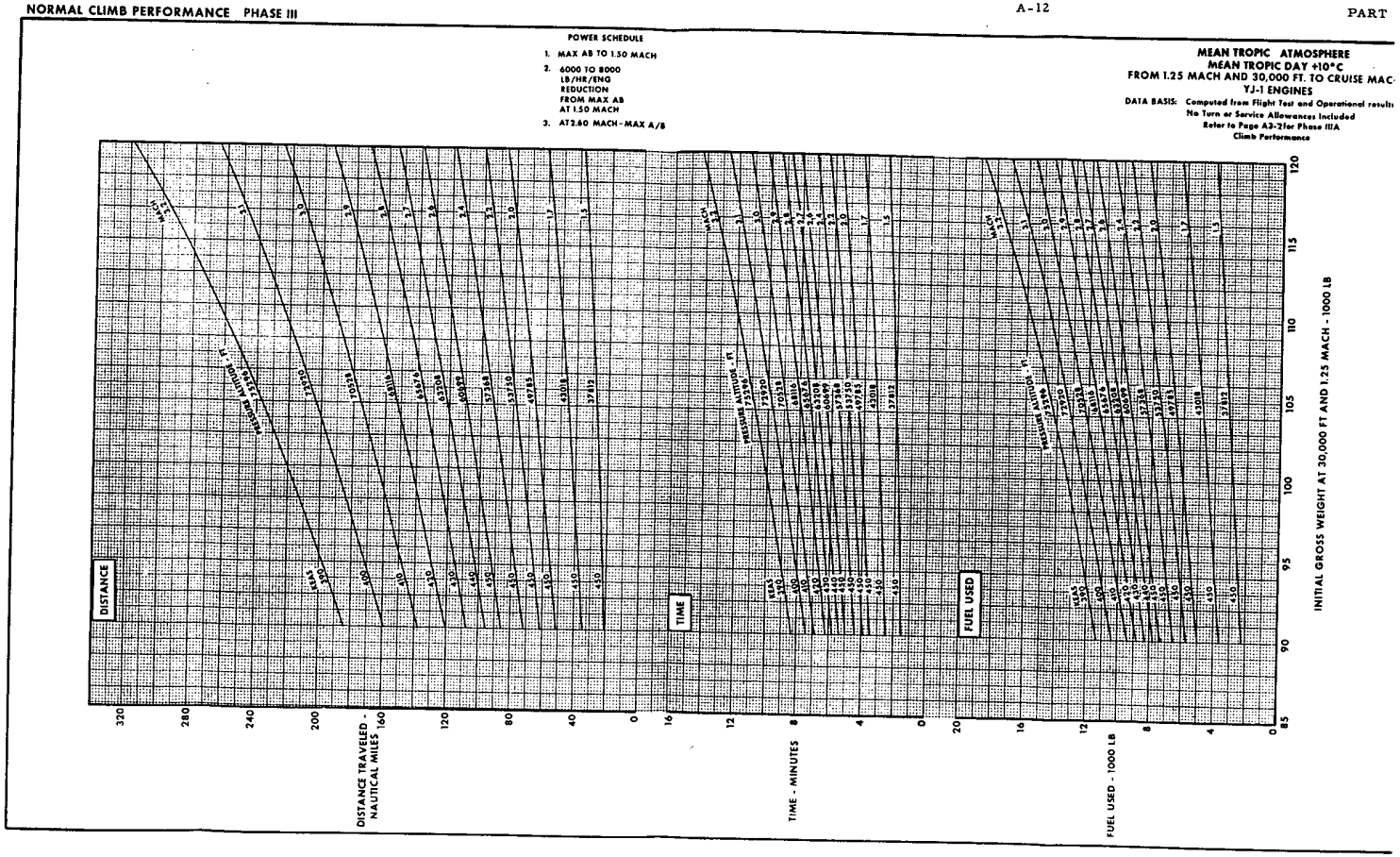
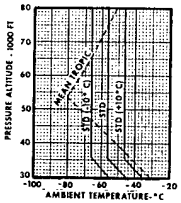

POWER SCHEDULE
1. MAX AB TO 1.50 MACH
2. 6000 TO 8000 LB/HR/ENG REDUCTION FROM MAX AB AT 1.50 MACH
3. AT 2.60 MACH - MAX A/B
MEAN TROPIC ATMOSPHERE
MEAN TROPIC DAY +10°C
FROM 1.25 MACH AND 30,000 FT. TO CRUISE MAC
YJ-1 ENGINES
DATA BASIS: Computed from Flight Test and Operational results
No Turn or Service Allowances Included
Refer to Page A3-2 for Phase IIIA Climb Performance
DISTANCE
TIME
FUEL USED
DISTANCE TRAVELED - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
INITIAL GROSS WEIGHT AT 30,000 FT AND 1.25 MACH - 1000 LB

Figure A3-12

NORMAL CLIMB PERFORMANCE

ADJUSTMENTS FOR OTHER END AR ALTITUDES

TEMP. FROM STD.	END AR ALTITUDE	MACH 2.9 - 68,200 FT.			MACH 3.1 - 73,000 FT			MACH 3.3 - 75,300		
		FUEL	TIME	DIST.	FUEL	TIME	DIST.	FUEL	TIME	DIST.
+10	26000	22250	17.4	296	24650	19.7	365	25950	21.0	404
	28000	22000	17.3	295	24250	19.6	364	25700	20.9	403
	32000	21500	17.0	294	23750	19.3	362	25050	20.6	401
STD	26000	19050	14.3	230	20750	15.8	273	21750	16.7	300
	28000	18750	14.3	229	20450	15.7	272	21350	16.7	299
	32000	18050	13.9	227	19850	15.4	271	20750	16.3	297
-10	26000	16850	12.2	187	18250	13.6	221	18950	14.0	239
	28000	16550	12.2	186	17950	13.4	220	18650	14.0	238
	32000	15900	11.9	183	17300	13.0	217	18000	13.6	236



1956 ARDC ATMOSPHERE
1 AB AR AT 30,000 FT
YJ-1 ENGINES

Climb Performance computed from Flight Test and Operational results. No turn or service allowances included. ZFW = 55,150 lb. and Fuel Remaining Off Tanker = 67,300 lb. Refer to Page A32 for Phase IIIA Climb Performance.

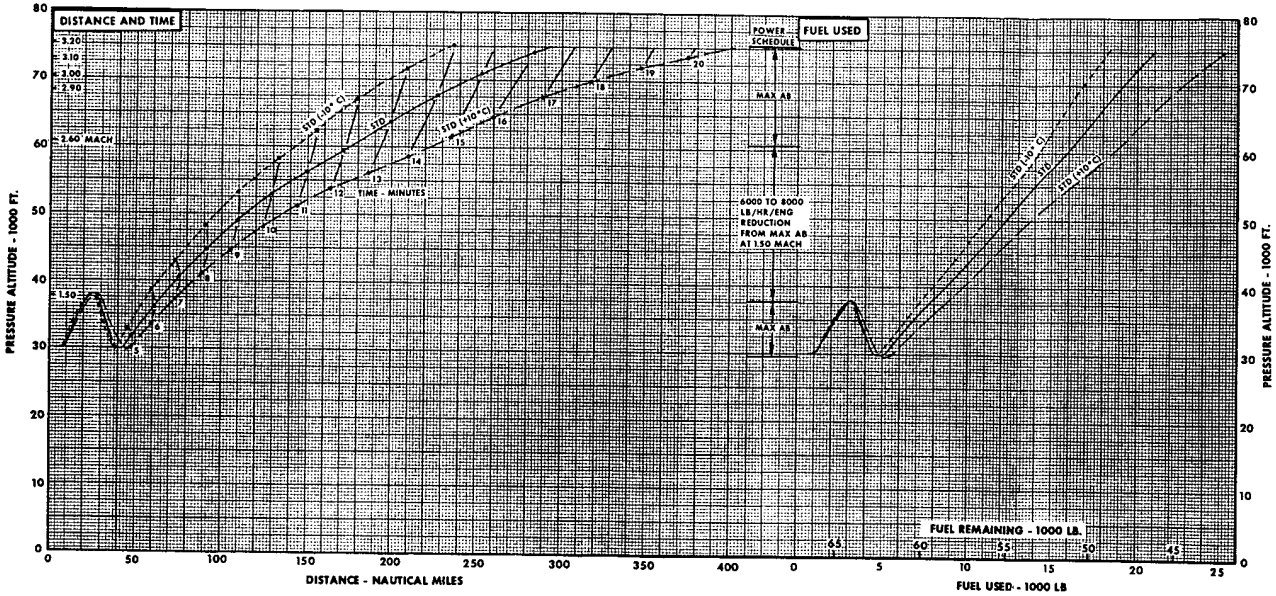


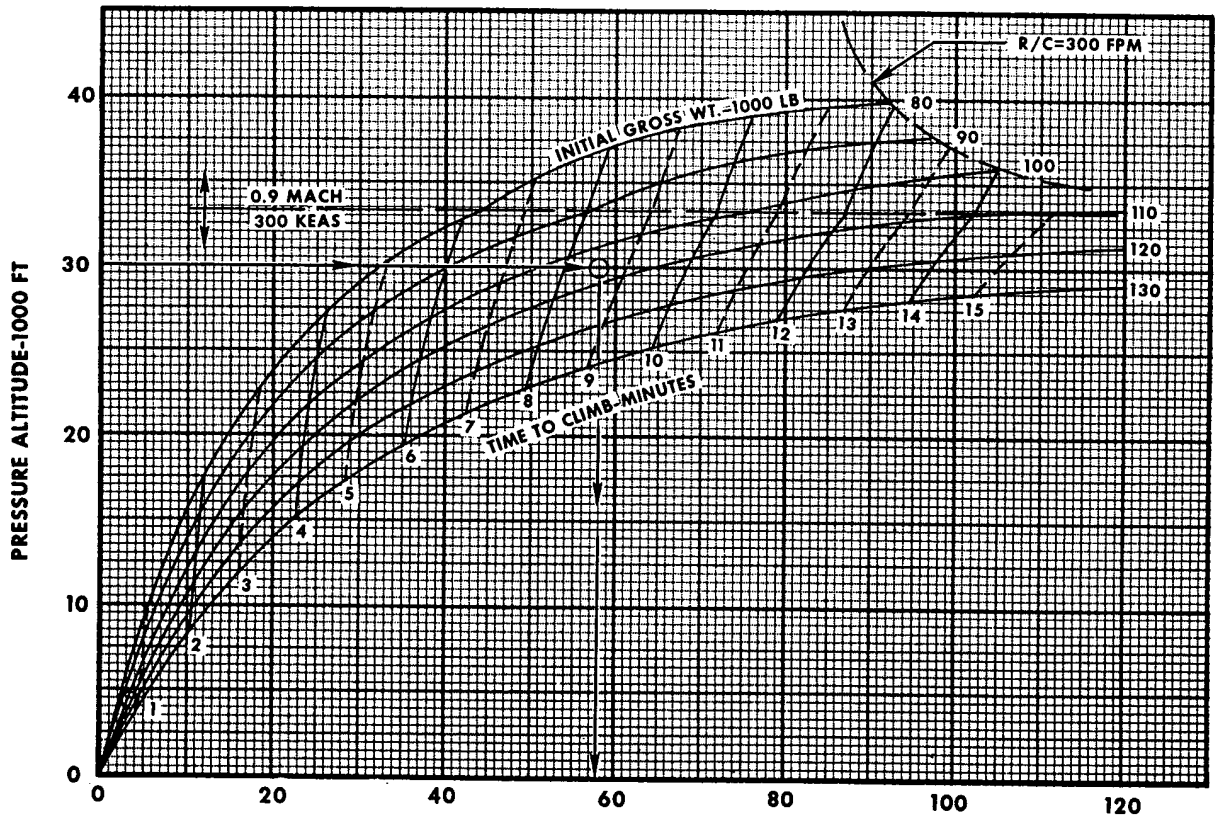
Figure A3-6

MILITARY THRUST CLIMB PERFORMANCE

STANDARD DAY
TWO ENGINE
300 KEAS TO 0.90 MACH
ZERO WIND

YJ-1 ENGINES

NOTES:
1. Data Basis: Estimated
2. No Turn or Service Allowances Included
3. Add Takeoff Allowance of 1800 Lb., 2.6 NMI, and 0.9 Minutes for Max Thrust Acceleration to 300 KEAS



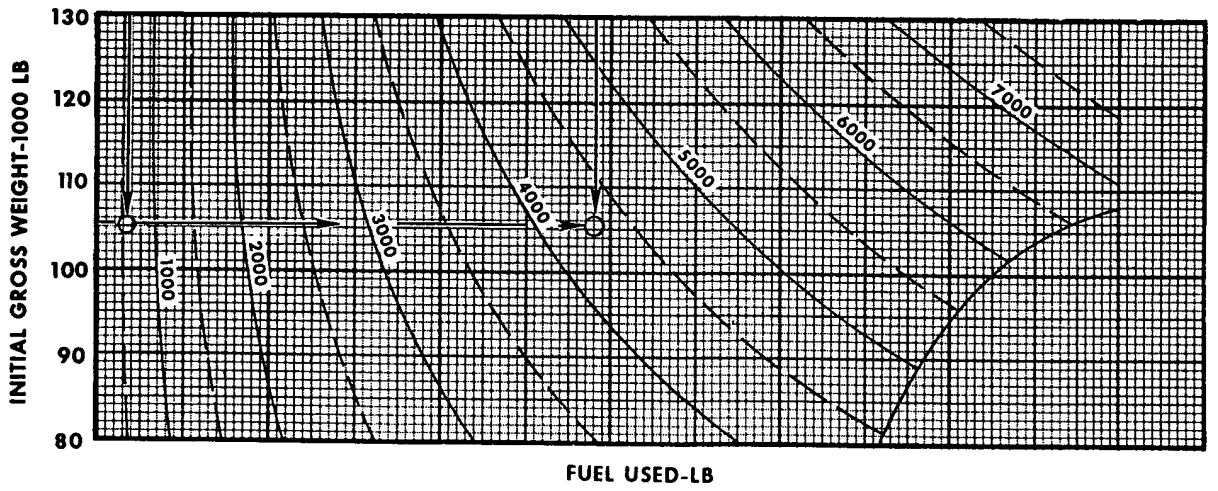


Figure A3-14

MILITARY THRUST CLIMB PERFORMANCE

STANDARD DAY-10°C
TWO ENGINE
300 KEAS TO 0.90 MACH
ZERO WIND

YJ-1 ENGINES

NOTES:
1. Data Basis: Estimated
2. No Turn or Service Allowances Included
3. Add Takeoff Allowance of 1800 Lb., 2.6 NMI, and 0.9 Minutes for Max Thrust Acceleration to 300 KEAS

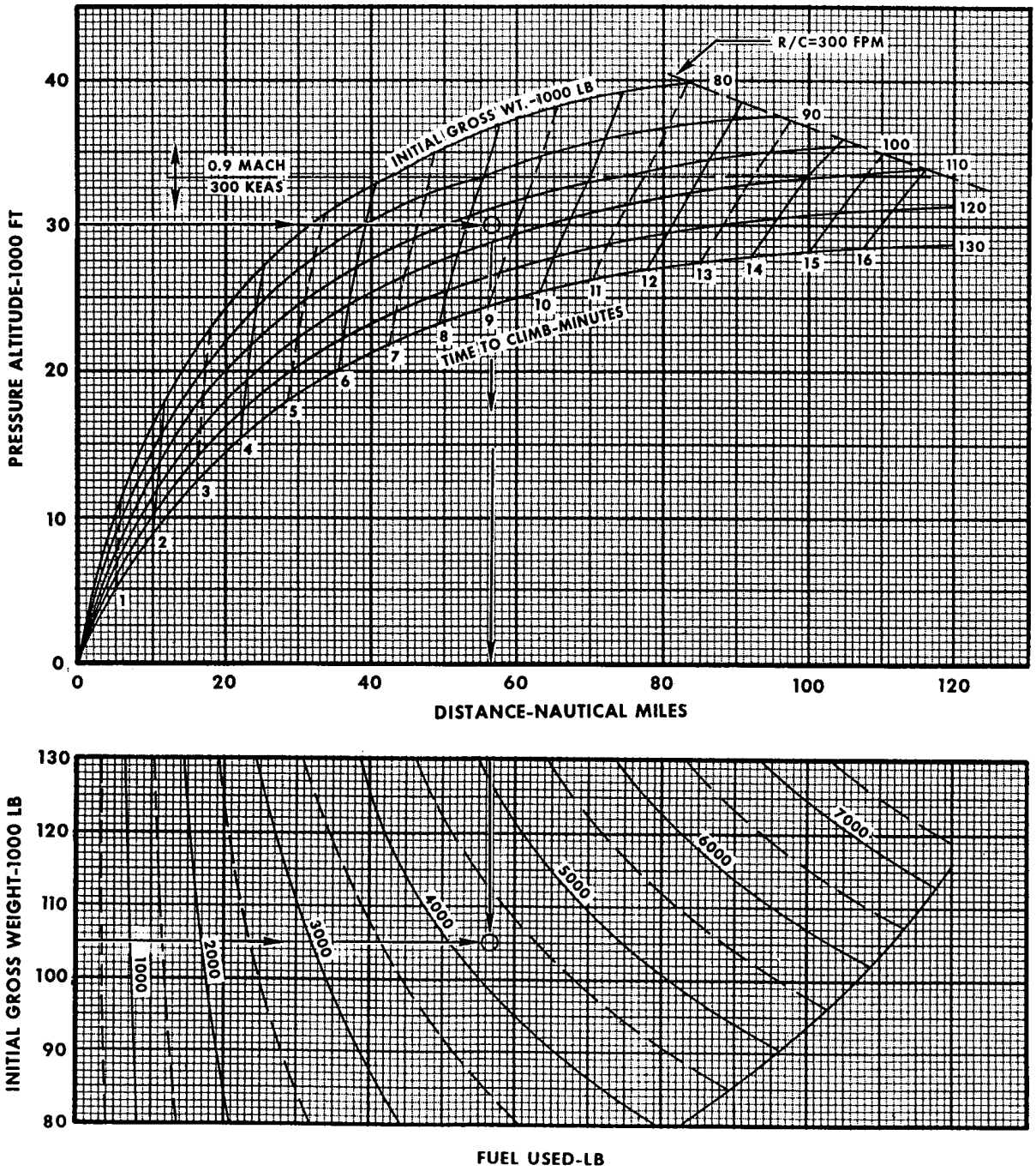
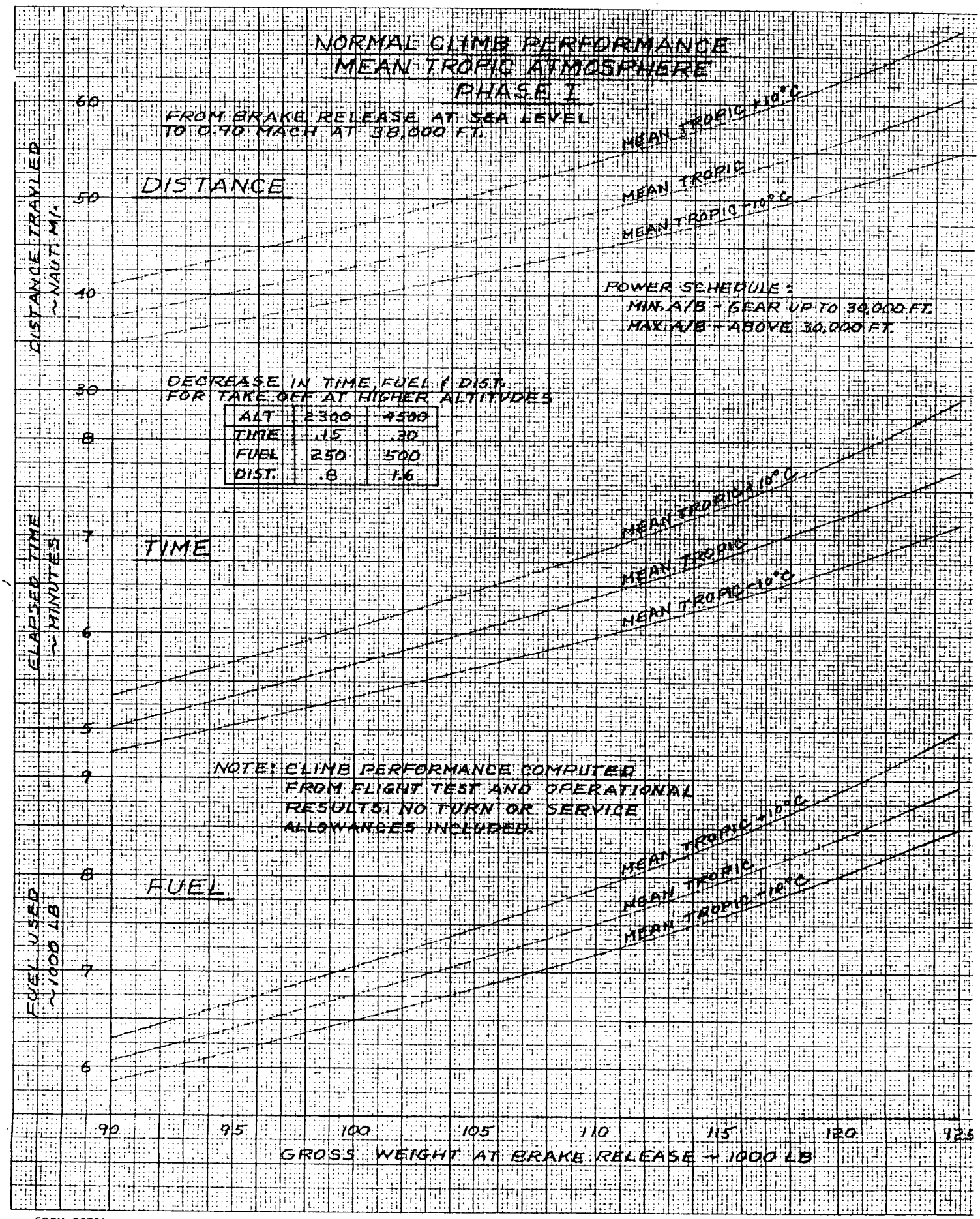


Figure A3-13



CLEARPRINT CHARTS

NORMAL CLIMB PERFORMANCE PHASE I

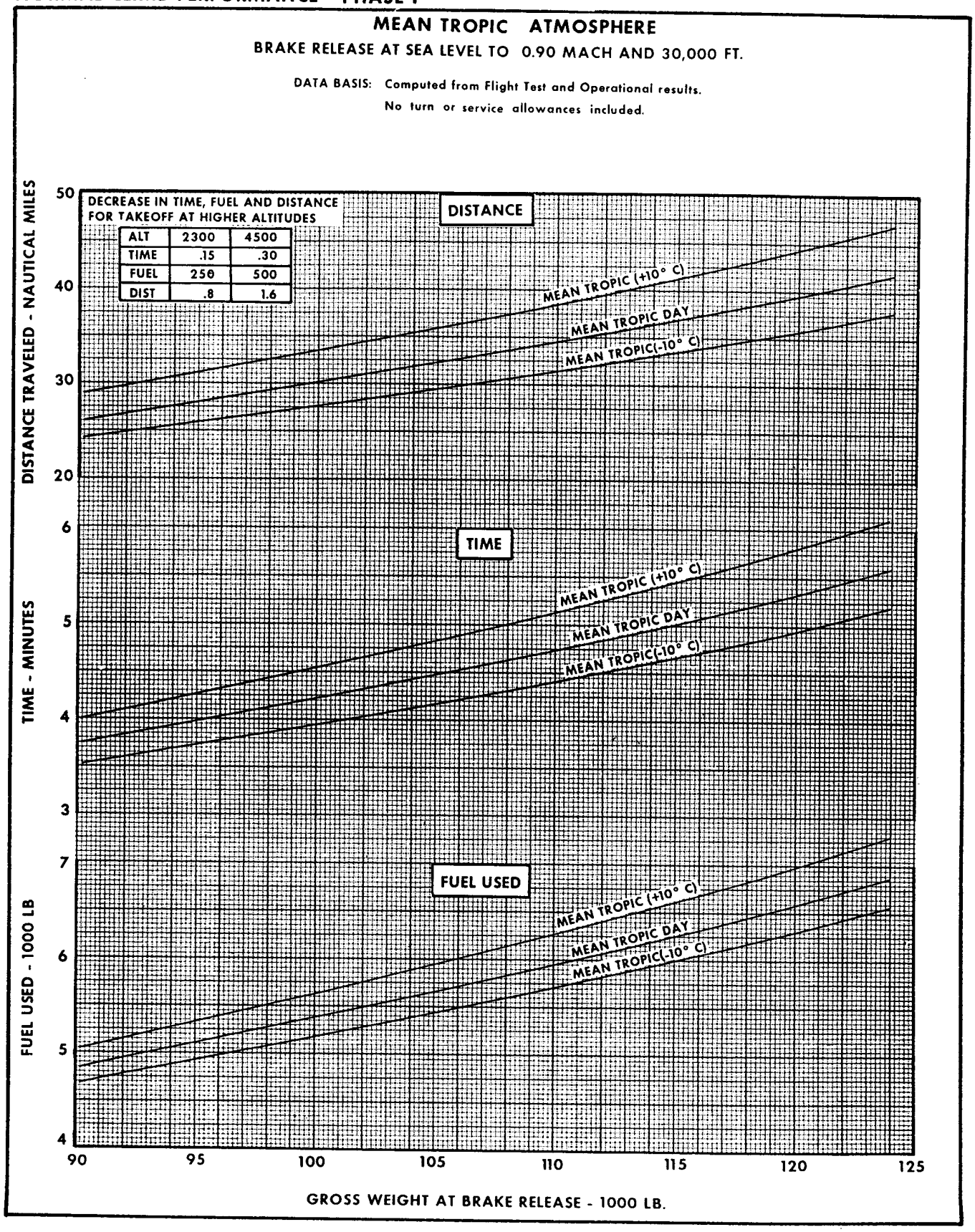


Figure A3-7

NORMAL CLIMB PERFORMANCE PHASE II

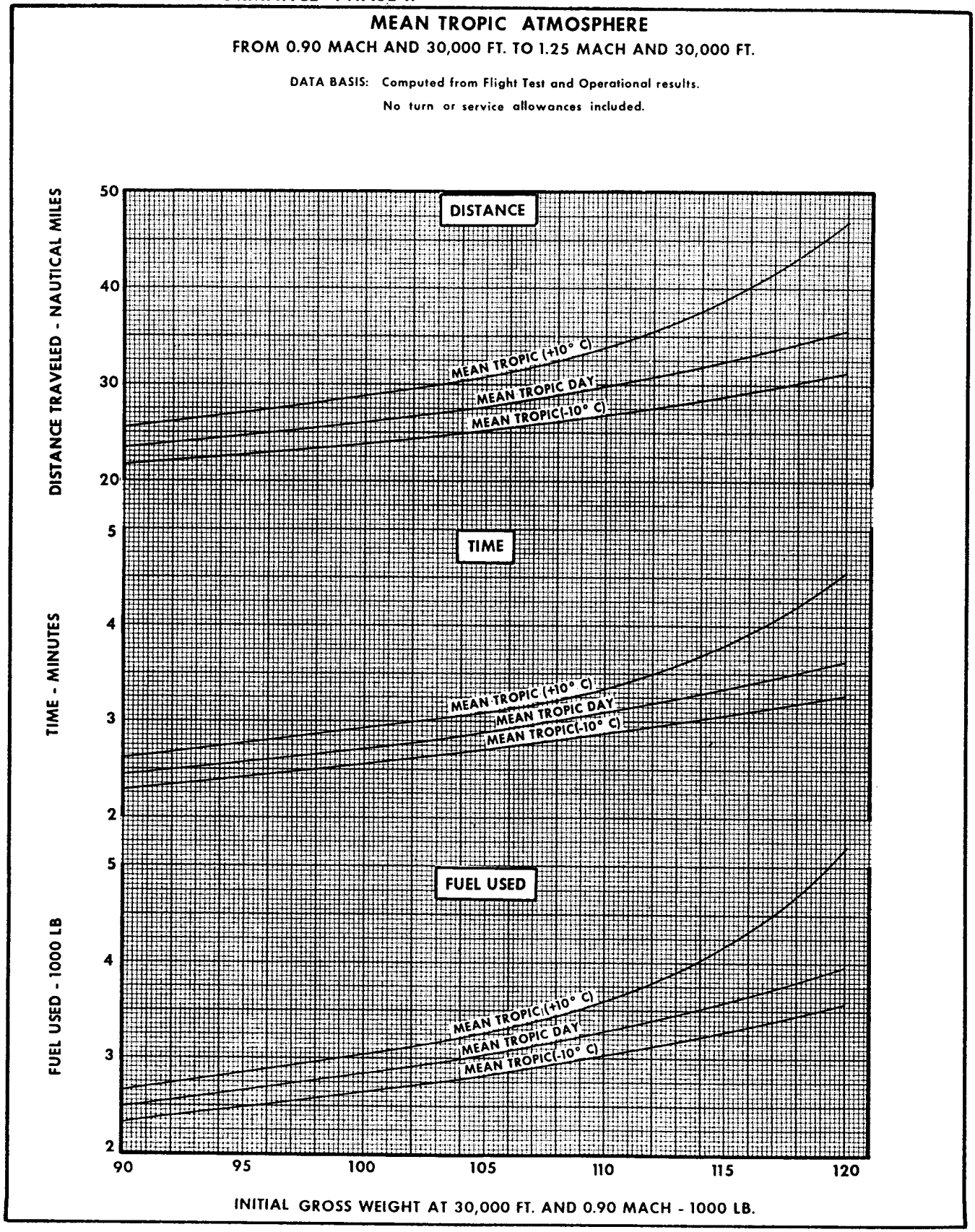
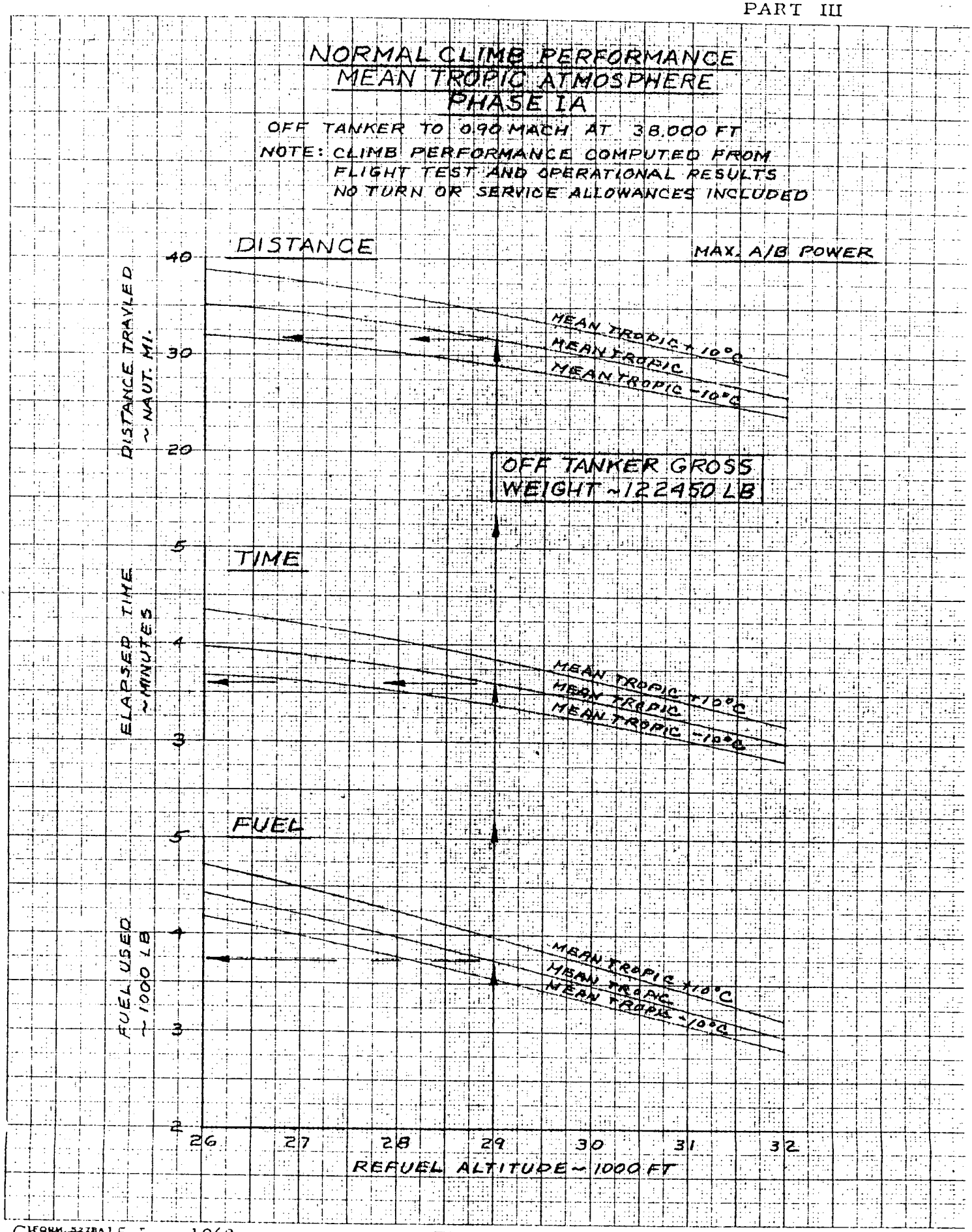
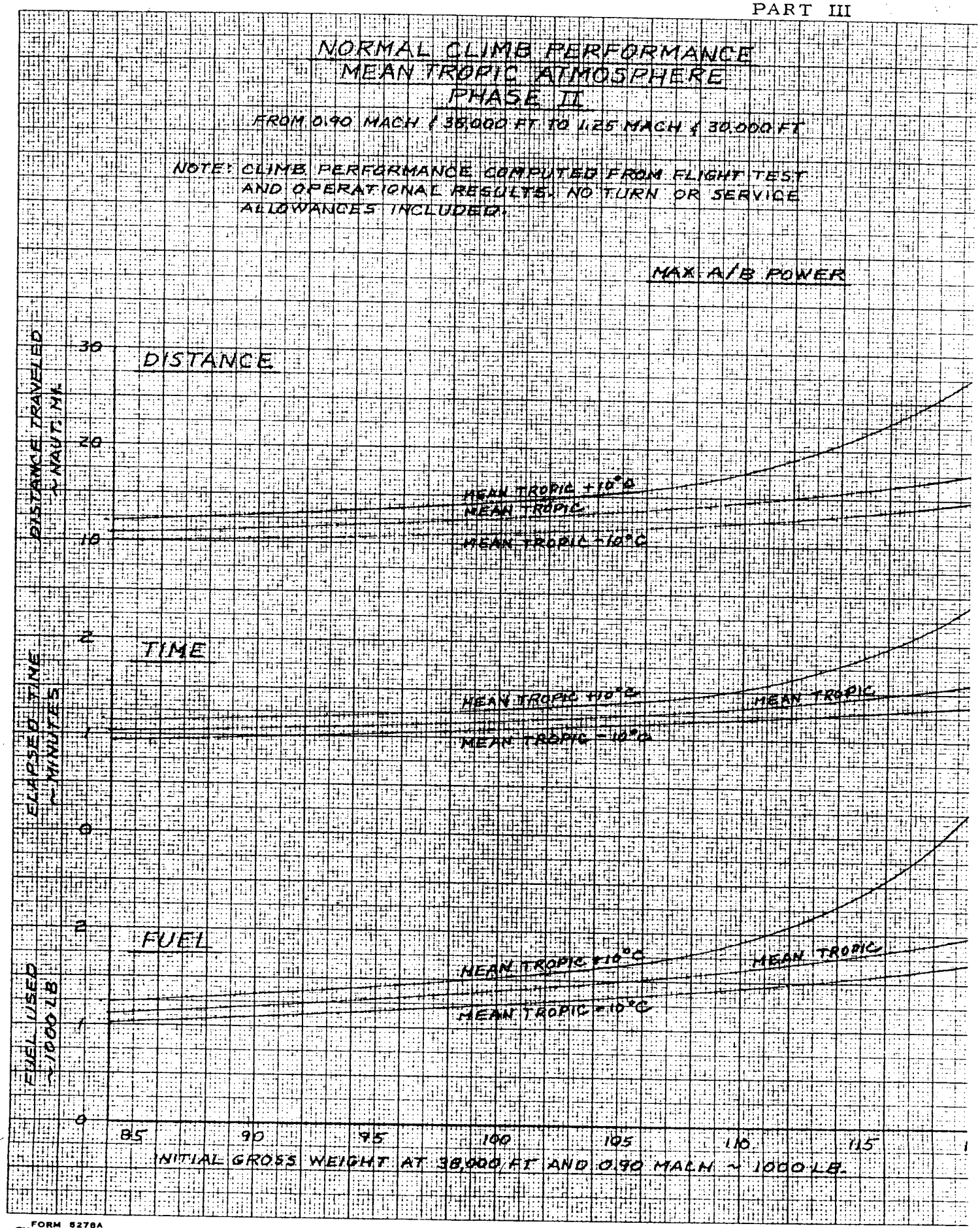


Figure A3-8



CLEARPRINT CHARTS


NORMAL CLIMB PERFORMANCE
MEAN TROPIC ATMOSPHERE
PHASE II
FROM 0.90 MACH & 36,000 FT TO 1.25 MACH & 30,000 FT
NOTE: CLIMB PERFORMANCE COMPUTED FROM FLIGHT TEST AND OPERATIONAL RESULTS. NO TURN OR SERVICE ALLOWANCES INCLUDED.
MAX A/B POWER
DISTANCE
DISTANCE TRAVELED ~ NAUT. MI.
30
20
10
MEAN TROPIC +10°C
MEAN TROPIC
MEAN TROPIC -10°C
TIME
ELAPSED TIME ~ MINUTES
2
1
0
MEAN TROPIC +10°C
MEAN TROPIC
MEAN TROPIC -10°C
FUEL
FUEL USED ~ 1000 LB
2
1
0
MEAN TROPIC +10°C
MEAN TROPIC
MEAN TROPIC -10°C
85
90
95
100
105
110
115
INITIAL GROSS WEIGHT AT 36,000 FT AND 0.90 MACH ~ 1000 LB.

NORMAL CLIMB PERFORMANCE PHASE III

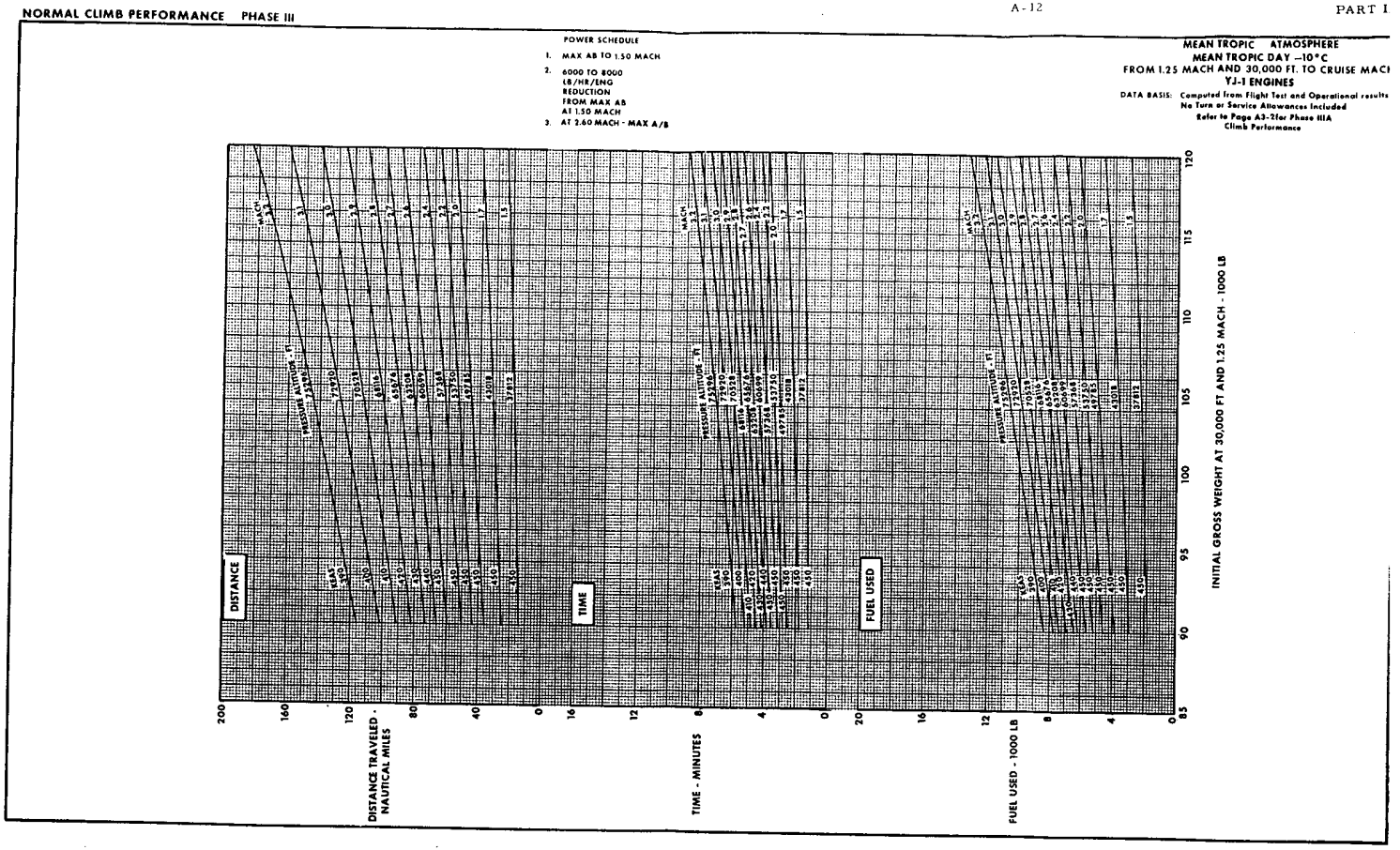

POWER SCHEDULE
1. MAX AB TO 1.50 MACH
2. 6000 TO 8000 LB/HR/ENG REDUCTION FROM MAX AB AT 1.50 MACH
3. AT 2.60 MACH - MAX A/B
MEAN TROPIC ATMOSPHERE
MEAN TROPIC DAY —10°C
FROM 1.25 MACH AND 30,000 FT. TO CRUISE MACH
YJ-1 ENGINES
DATA BASIS: Computed from Flight Test and Operational results
No Turn or Service Allowances Included
Refer to Page A3-7for Phase IIIA Climb Performance
DISTANCE
TIME
FUEL USED
DISTANCE TRAVELED - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
INITIAL GROSS WEIGHT AT 30,000 FT AND 1.25 MACH - 1000 LB

Figure A3-9

Changed 15 March 1968

NORMAL CLIMB PERFORMANCE PHASE III

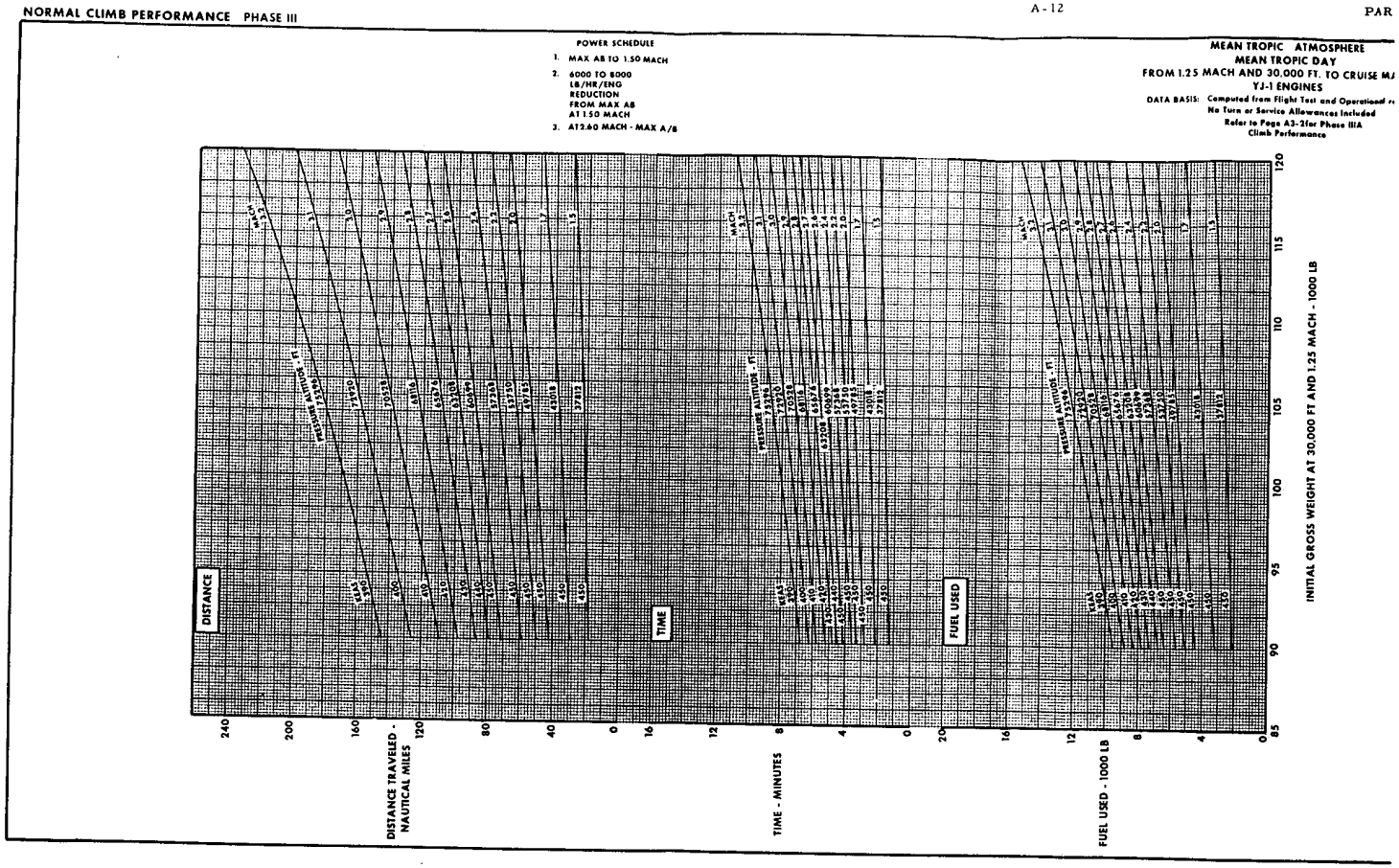

POWER SCHEDULE
1. MAX AB TO 1.50 MACH
2. 6000 TO 8000 LB/HR/ENG REDUCTION FROM MAX AB AT 1.50 MACH
3. AT 2.60 MACH - MAX A/B
MEAN TROPIC ATMOSPHERE
MEAN TROPIC DAY
FROM 1.25 MACH AND 30,000 FT. TO CRUISE MA
YJ-1 ENGINES
DATA BASIS: Computed from Flight Test and Operational re
No Turn or Service Allowances Included
Refer to Page A3-2for Phase IIIA Climb Performance
DISTANCE
TIME
FUEL USED
DISTANCE TRAVELED - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
INITIAL GROSS WEIGHT AT 30,000 FT AND 1.25 MACH - 1000 LB

Figure A3-10

Changed 15 March 1968

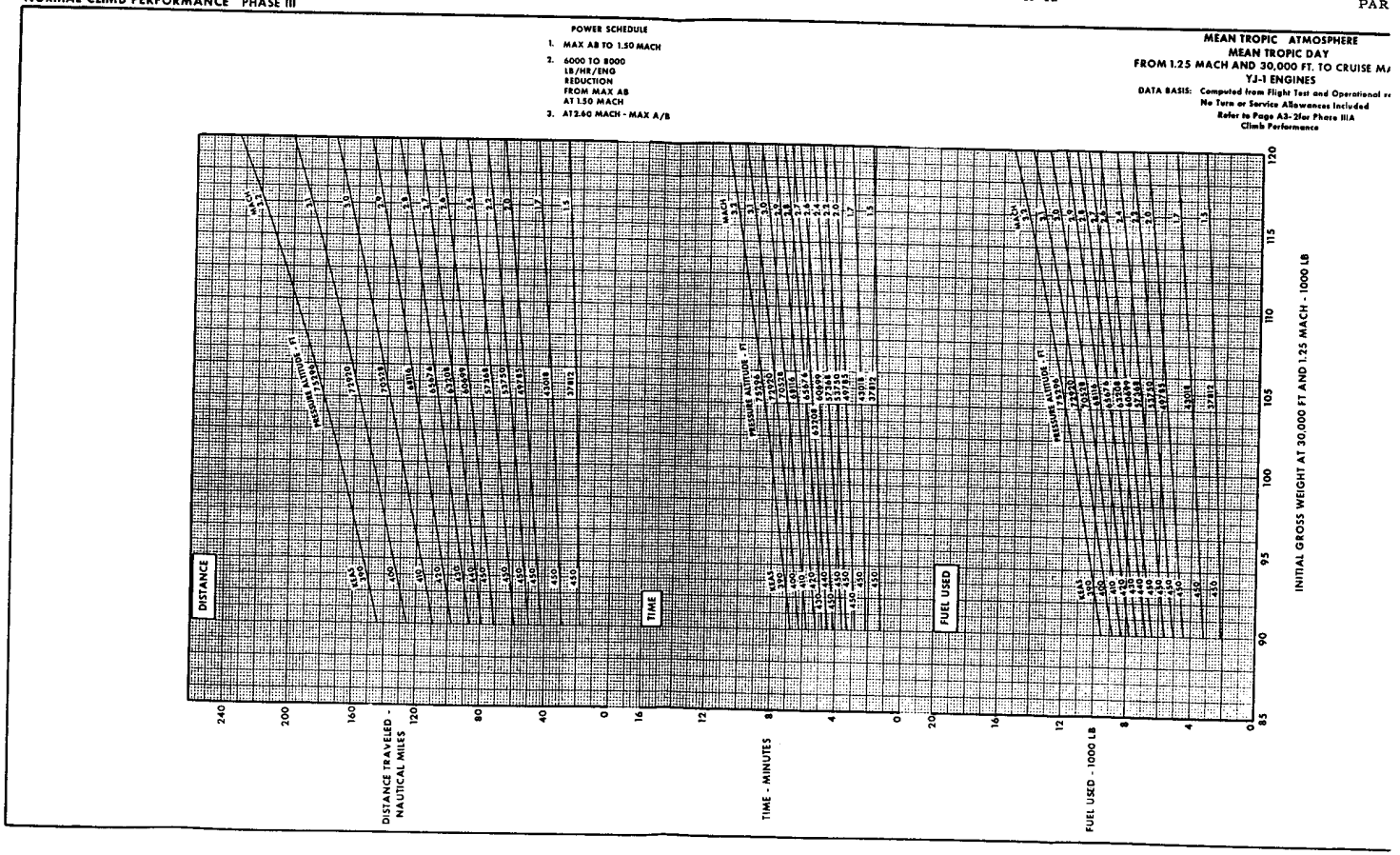
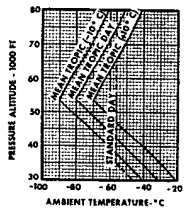

POWER SCHEDULE
1. MAX AB TO 1.50 MACH
2. 6000 TO 8000 LB/HR/ENG REDUCTION FROM MAX AB AT 1.50 MACH
3. AT 2.60 MACH - MAX A/B
MEAN TROPIC ATMOSPHERE
MEAN TROPIC DAY
FROM 1.25 MACH AND 30,000 FT. TO CRUISE MA
YJ-1 ENGINES
DATA BASIS: Computed from Flight Test and Operational re
No Turn or Service Allowances Included
Refer to Page A3-2for Phase IIIA Climb Performance
DISTANCE
TIME
FUEL USED
DISTANCE TRAVELED - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
INITIAL GROSS WEIGHT AT 30,000 FT AND 1.25 MACH - 1000 LB

Figure A3-11

NORMAL CLIMB PERFORMANCE

ADJUSTMENTS FOR OTHER END AR ALTITUDES

TEMP. FROM STD.	END AR ALTITUDE	MACH 2.9 - 68,200 FT FUEL	TIME	DIST.	MACH 3.1 - 73,000 FT FUEL	TIME	DIST.	MACH 3.2 - 73,300 FUEL	TIME	DIST.
+10	26000	21300	16.1	247	23700	18.4	311	25100	19.8	359
	28000	21000	16.0	246	23400	18.2	310	24800	19.7	358
	32000	20350	15.5	244	22850	17.8	306	24000	19.3	356
STD	26000	18150	13.4	200	20100	15.0	248	21050	16.0	276
	28000	17900	13.2	198	19800	14.8	246	20700	15.8	275
	32000	17300	12.8	195	18800	14.5	243	20200	15.5	273
-10	26000	16300	11.6	168	17800	12.9	202	18700	13.6	224
	28000	15950	11.5	166	17500	12.7	200	18350	13.4	222
	32000	15500	11.1	163	17000	12.3	197	17650	13.0	219



MEAN TROPIC ATMOSPH
AFTER AIR REFUELING
1 AB AR AT 30,000 FT
YJ-1 ENGINES

Climb Performance computed from Flight Test and Operational results. No turn or service allowances included. ZFW = 55,150 lb. and Fuel Remainin; Off Tanker = 67,200 lb.
Refer to Page A32 for Phase IIIA Climb Performance.

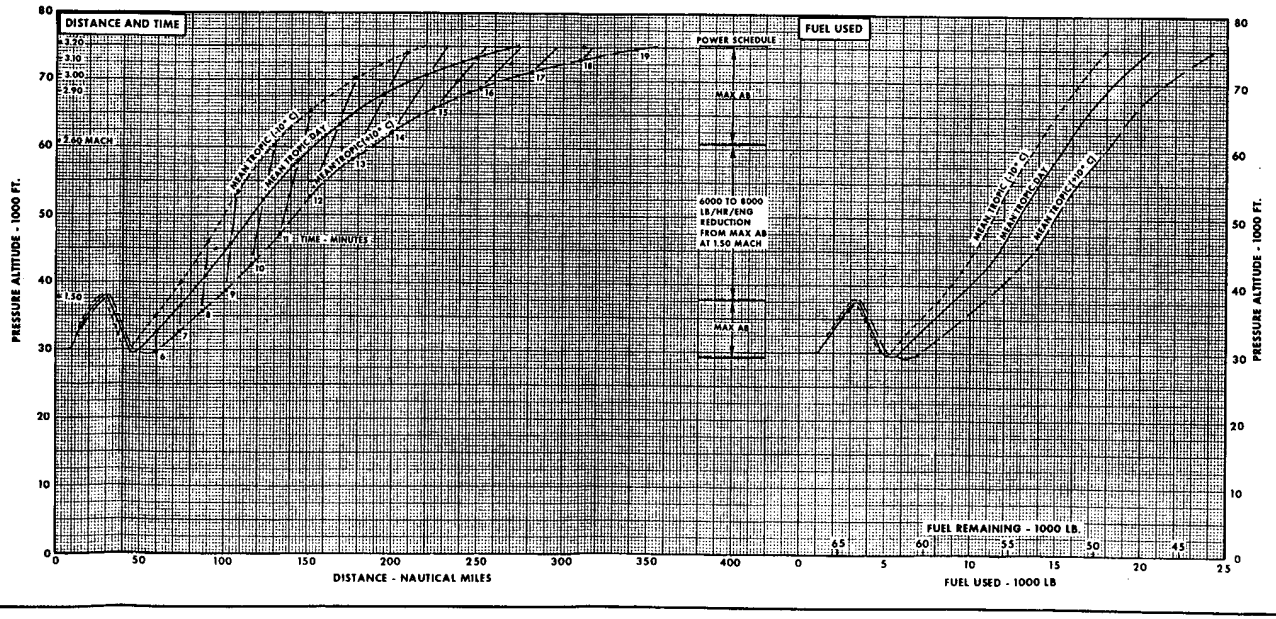


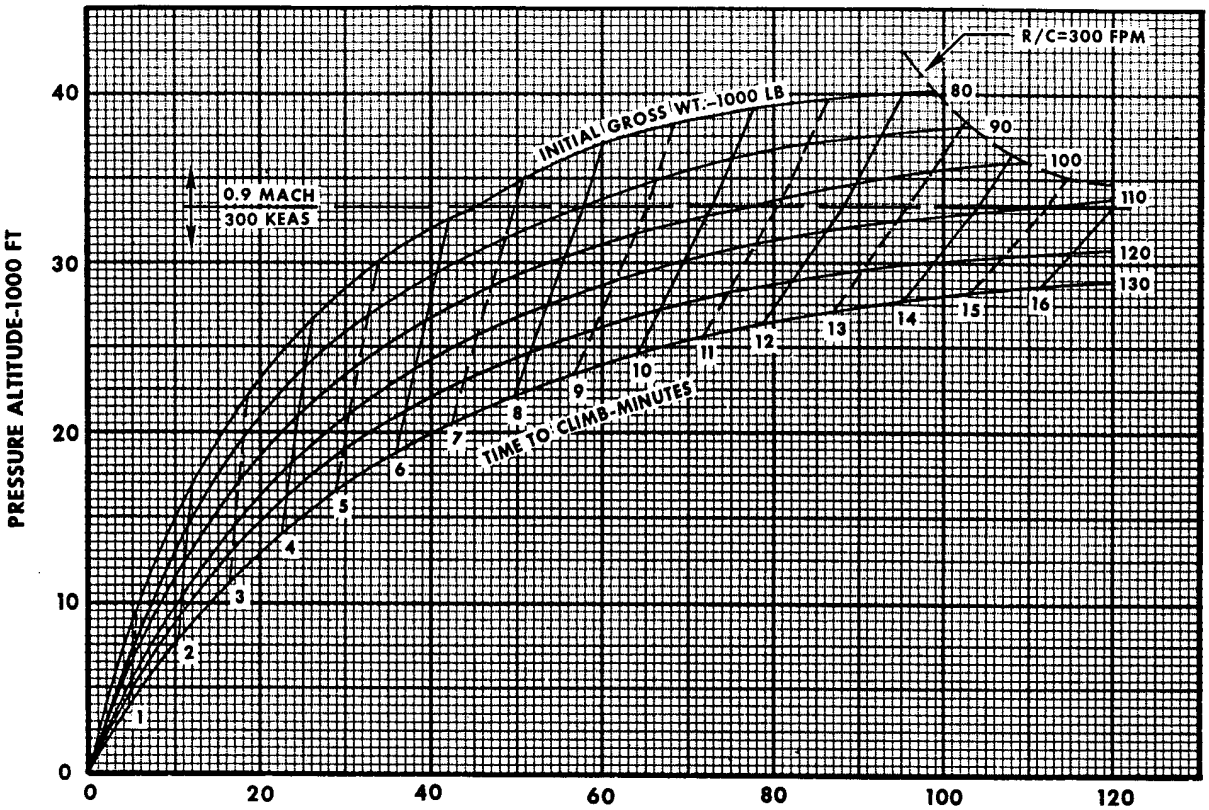
Figure A3-12

MILITARY THRUST CLIMB PERFORMANCE

STANDARD DAY+10°C
TWO ENGINE
300 KEAS TO 0.90 MACH
ZERO WIND

YJ-1 ENGINES

NOTES:
1. Data Basis: Estimated
2. No Turn or Service Allowances Included
3. Add Takeoff Allowance of 1800 Lb., 2.6 NMI, and 0.9 Minutes for Max Thrust Acceleration to 300 KEAS



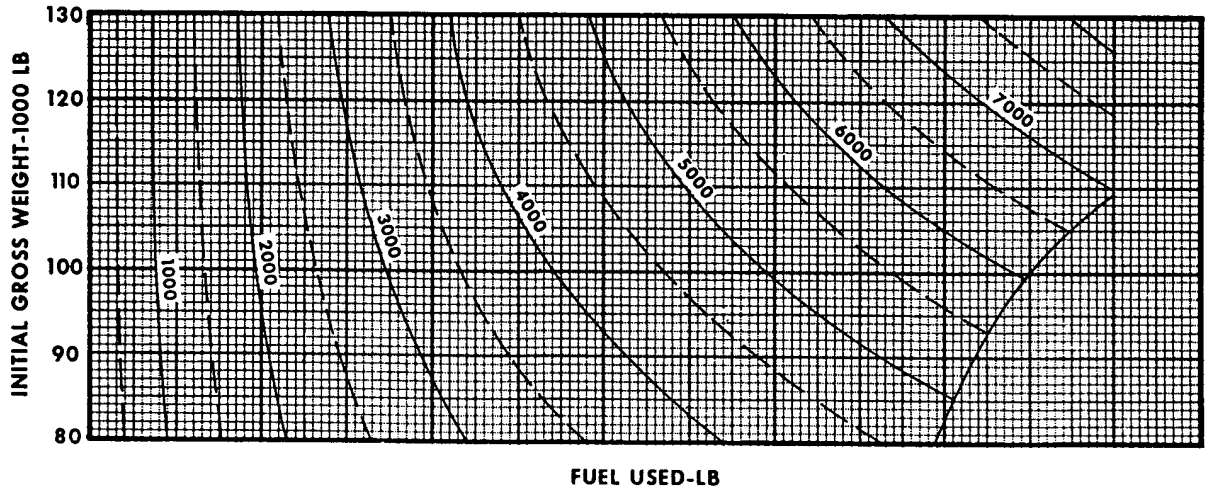


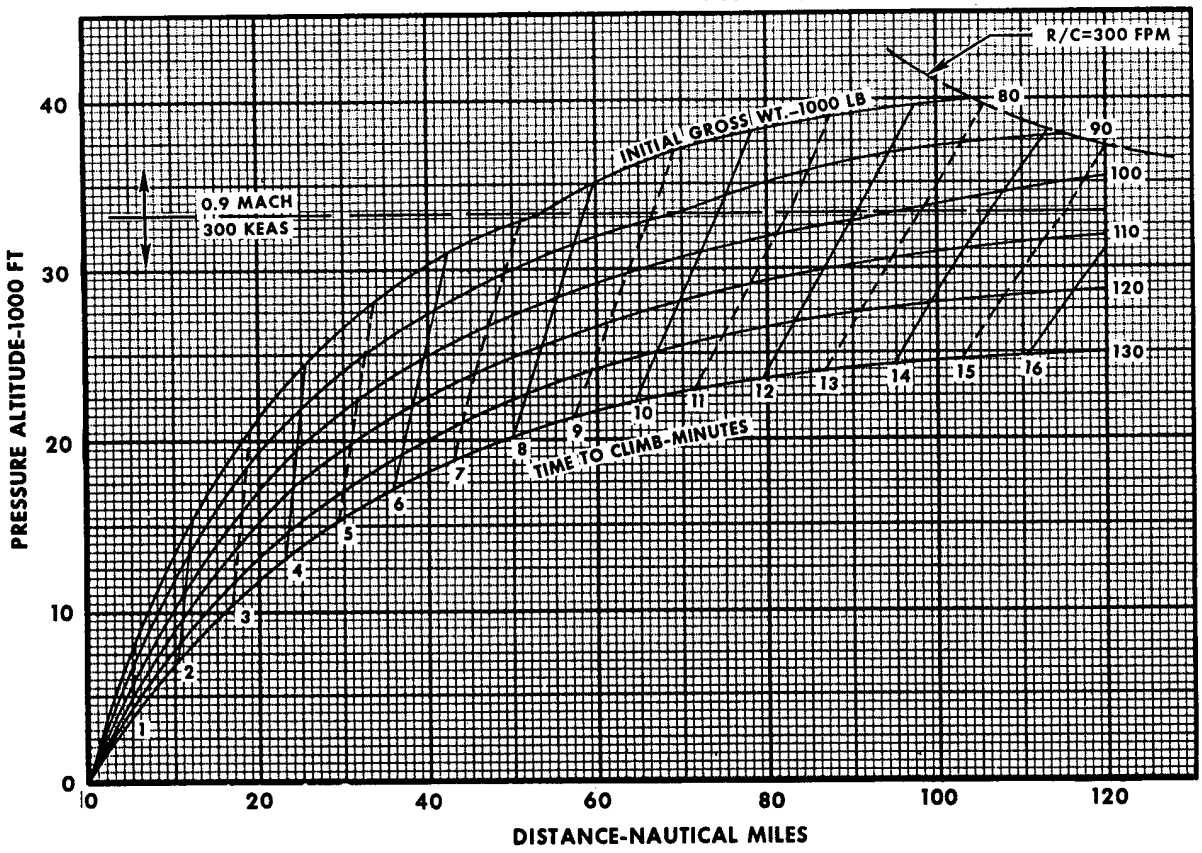
Figure A3-15

MILITARY THRUST CLIMB PERFORMANCE

STANDARD DAY+24.5°C
TWO ENGINE
300 KEAS TO 0.90 MACH
ZERO WIND

YJ-1 ENGINES

NOTES:
1. Data Basis: Estimated
2. No Turn or Service Allowances Included
3. Add Takeoff Allowance of 1800 Lb., 2.6 NMI, and 0.9 Minutes for Max Thrust Acceleration to 300 KEAS



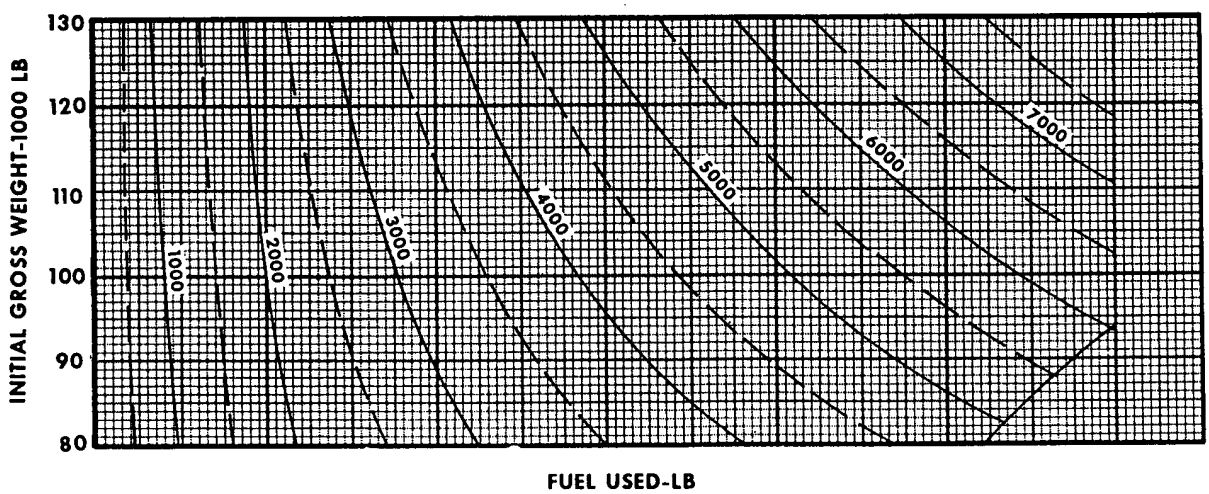


Figure A3-16

NORMAL DESCENT PERFORMANCE

TWO ENGINE
300 KEAS

DATA BASIS:
1.) Operational Tests with YJ & YJ-1 Engines
2.) Power Schedule:
Military Power to 2.50 Mach
Set 6800 RPM at 2.50 Mach
Set 6000 RPM at 1.50 Mach
3.) Spikes & Forward Bypass Auto.
4.) Aft Bypass closed.
Position 'A' at 3.00 Mach
Position 'B' at 2.70 Mach
Closed at 1.70 Mach
5.) No turn or service allowances included.

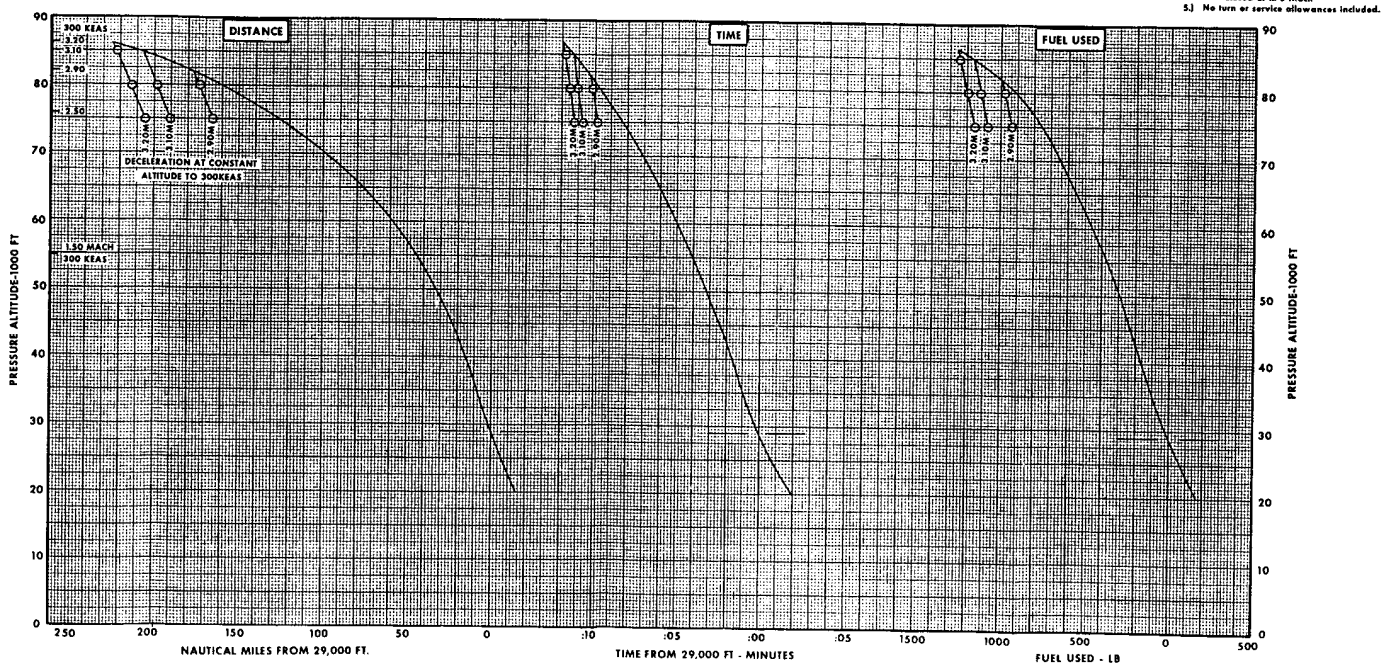


Figure A3-17

DESCENT PERFORMANCE

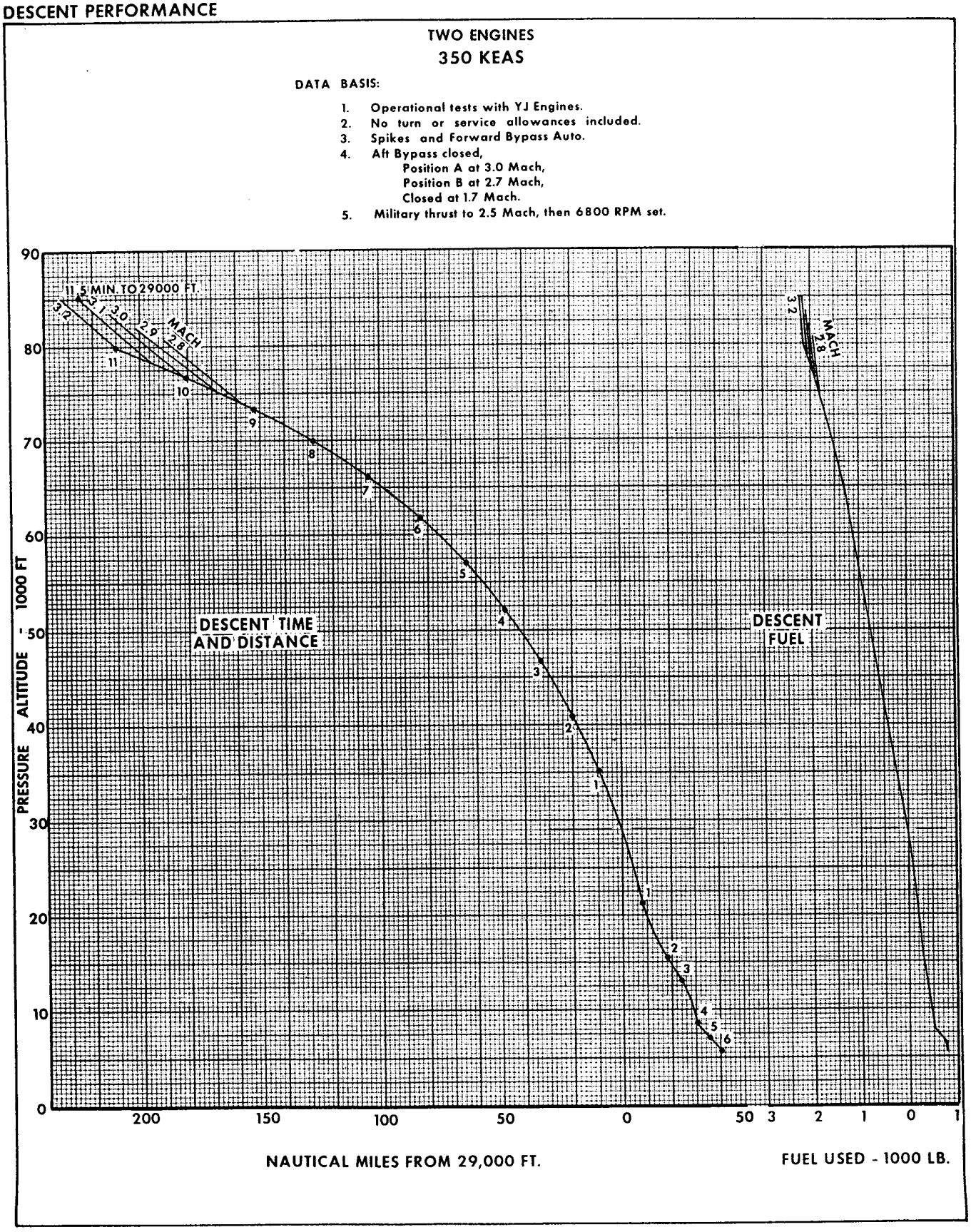


Figure A3-18

DESCENT PERFORMANCE

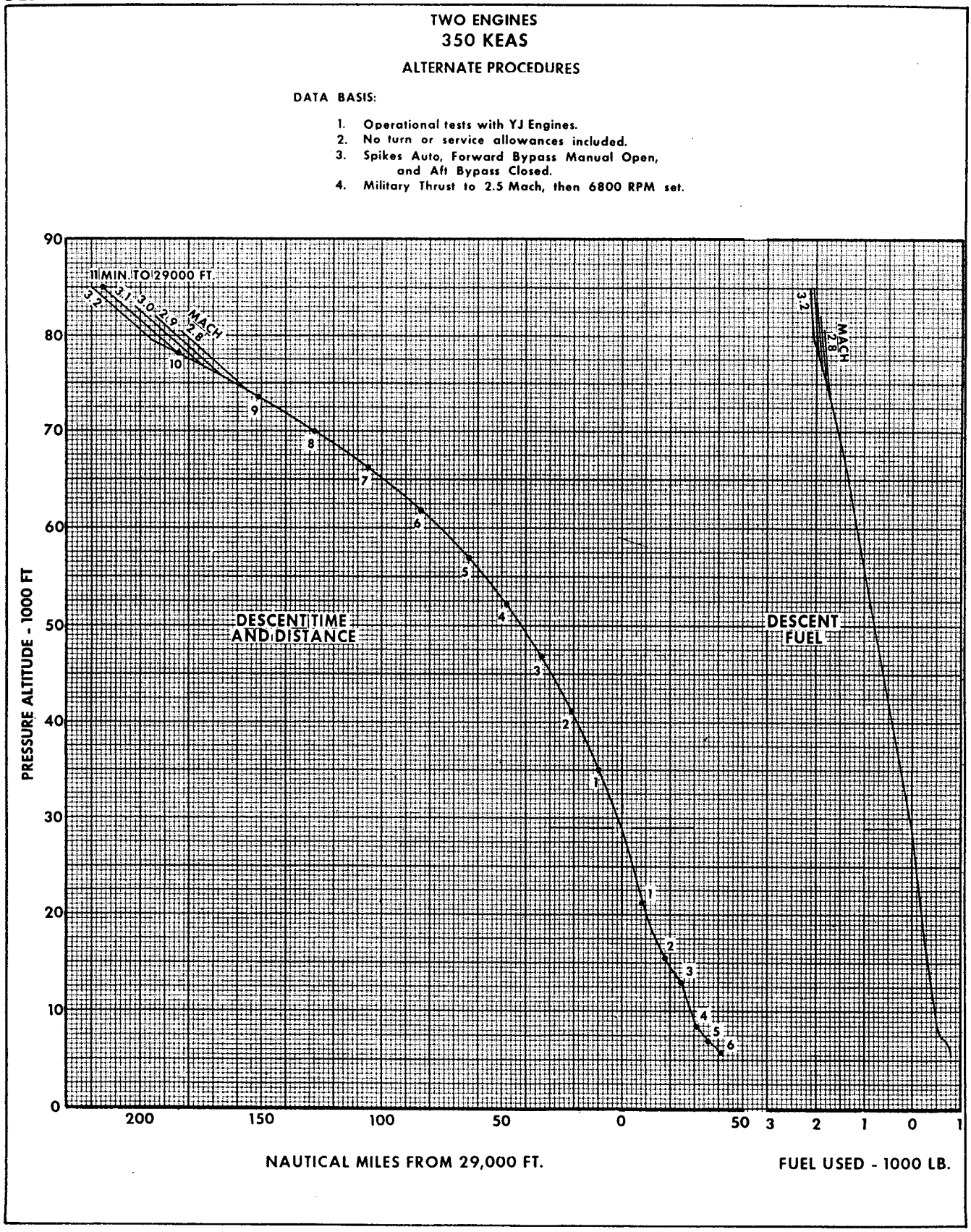


Figure A3-19

SINGLE ENGINE DESCENT SUMMARY

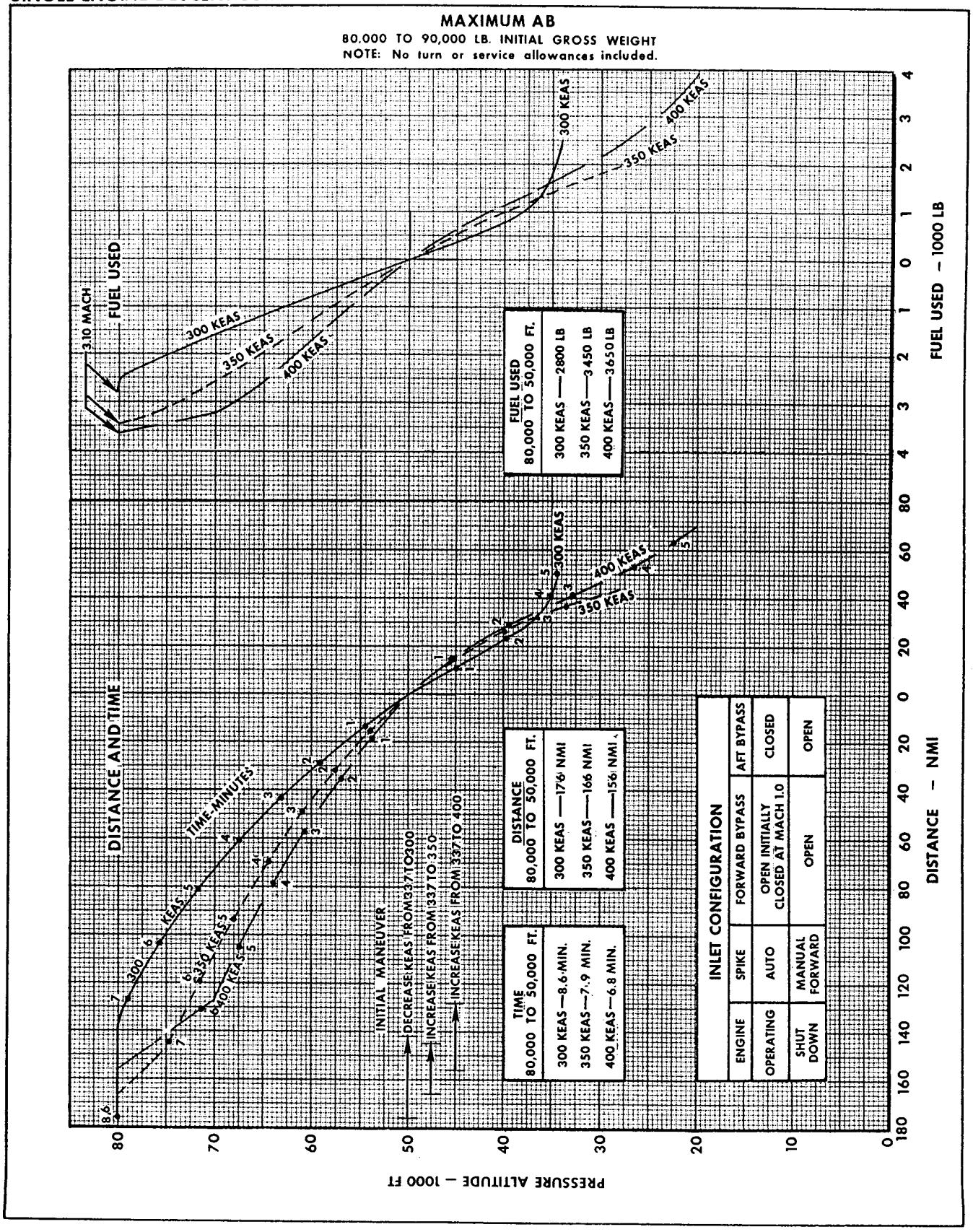


Figure A3-20

SINGLE ENGINE DESCENT

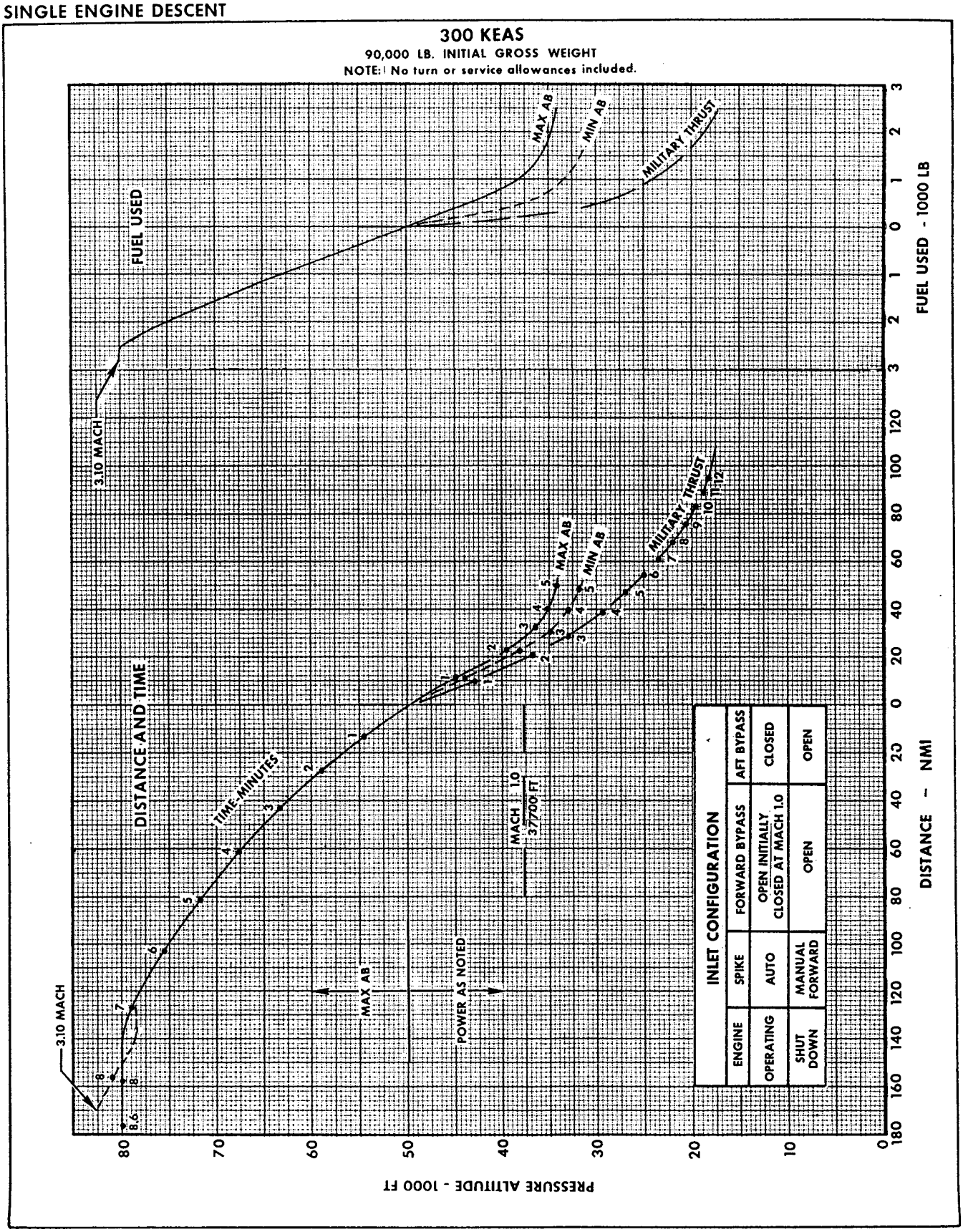


Figure A3-21

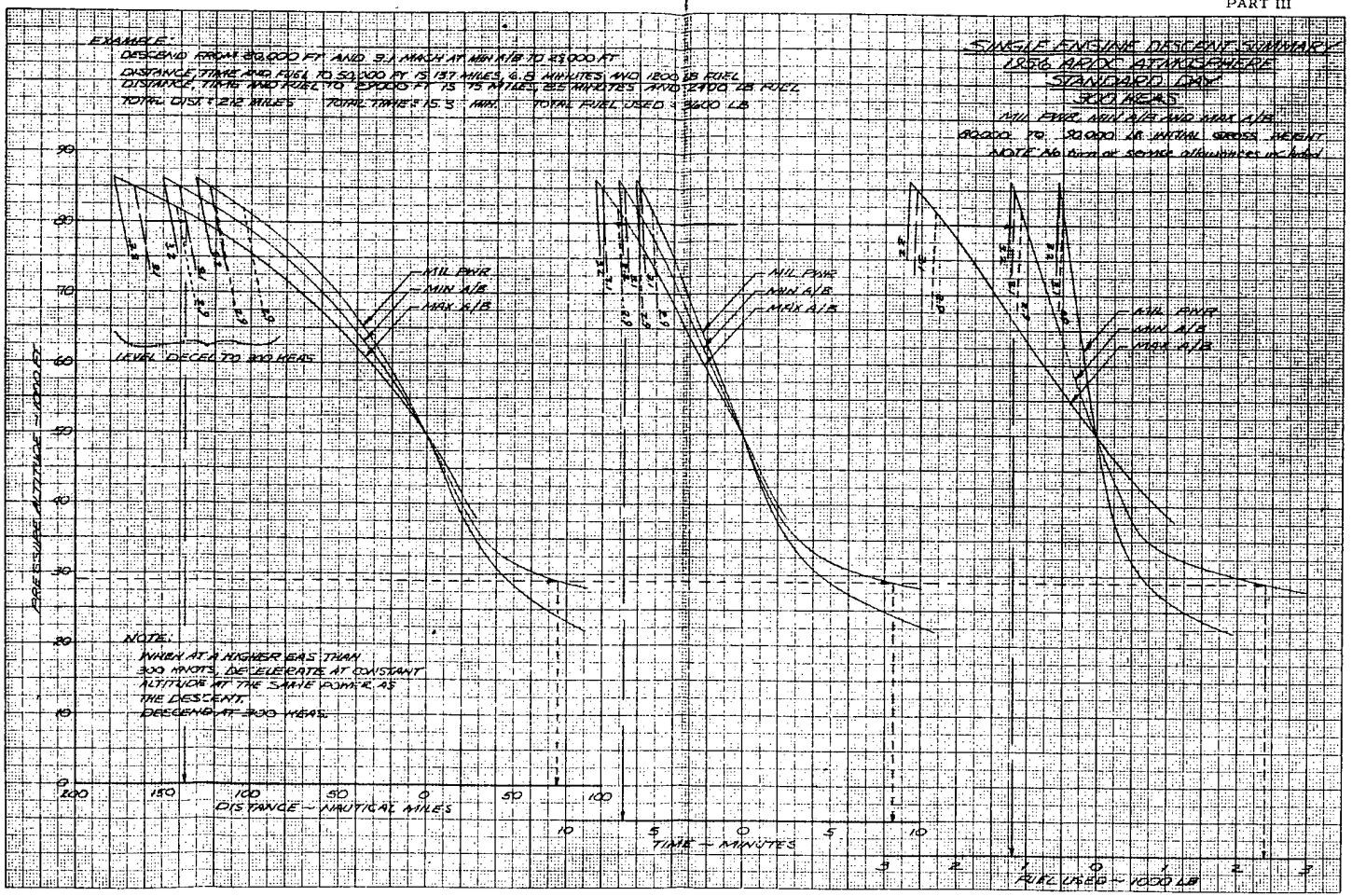
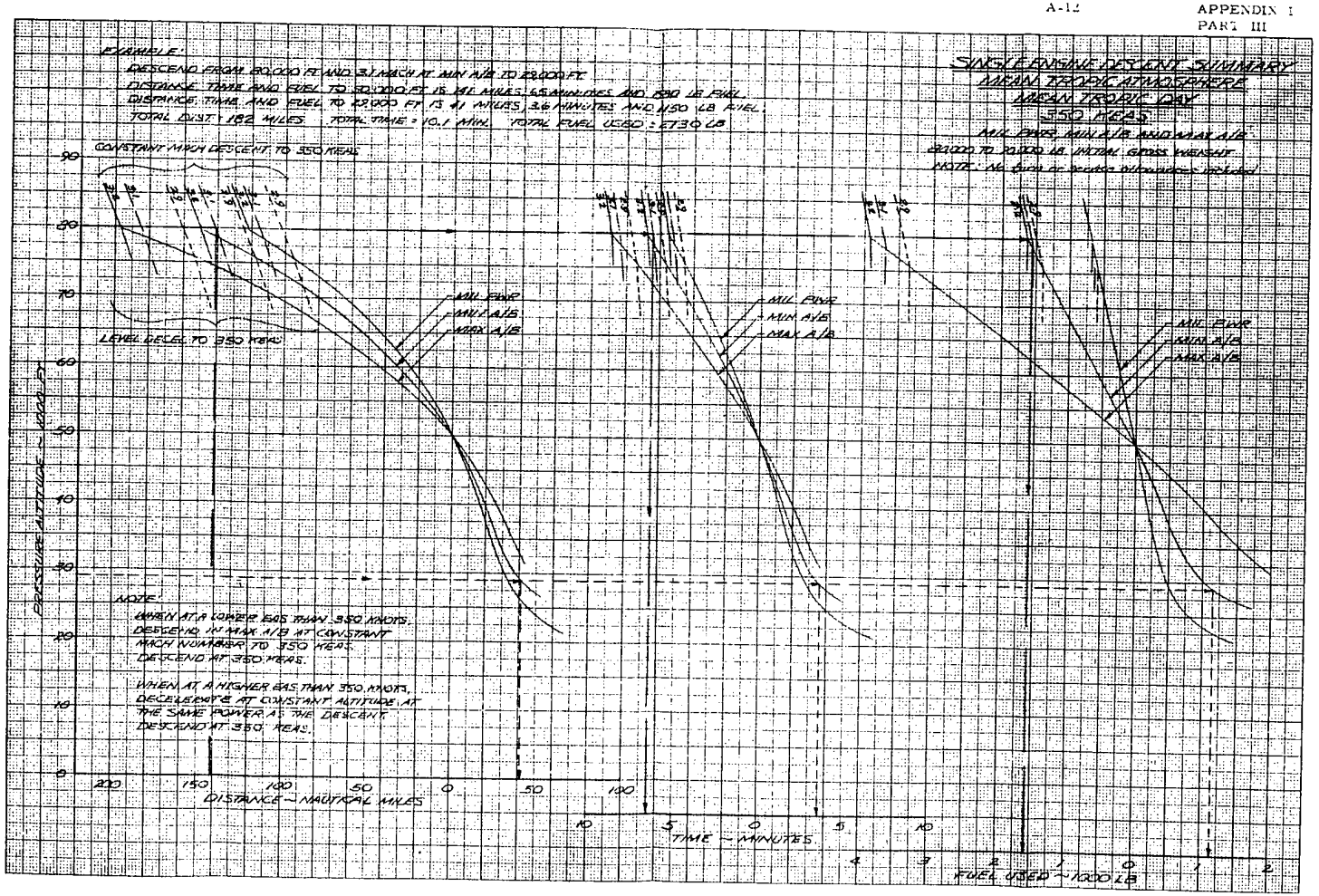

SINGLE ENGINE DESCENT SUMMARY
1956 ARDC ATMOSPHERE
STANDARD DAY
300 KEAS
MIL PWR, MIN A/B AND MAX A/B
80,000 TO 90,000 LB INITIAL GROSS WEIGHT
NOTE No turn or service allowances included
EXAMPLE:
DESCEND FROM 80,000 FT AND 3.1 MACH AT MIN A/B TO 25,000 FT
DISTANCE, TIME AND FUEL TO 50,000 FT IS 137 MILES, 6.8 MINUTES AND 1200 LB FUEL
DISTANCE, TIME AND FUEL TO 29000 FT IS 75 MILES, 25 MINUTES AND 2400 LB FUEL
TOTAL DIST = 212 MILES TOTAL TIME = 15.3 MIN. TOTAL FUEL USED = 3600 LB
MIL PWR
MIN A/B
MAX A/B
LEVEL DECEL TO 300 KEAS
NOTE:
WHEN AT A HIGHER EAS THAN 300 KNOTS, DECELERATE AT CONSTANT ALTITUDE AT THE SAME POWER AS THE DESCENT.
DESCEND AT 300 KEAS.
PRESSURE ALTITUDE — 1000 FT
DISTANCE — NAUTICAL MILES
TIME — MINUTES
FUEL USED — 1000 LB

Figure A-20


EXAMPLE:
DESCEND FROM 30,000 FT AND 3.1 MACH AT MAX A/B TO 22,000 FT.
DISTANCE TIME AND FUEL TO 30,000 FT 15 NAUTICAL MILES, 65 MINUTES AND 890 LB FUEL.
DISTANCE TIME AND FUEL TO 22,900 FT 13 NAUTICAL MILES, 3.6 MINUTES AND 1150 LB FUEL.
TOTAL DIST = 182 MILES TOTAL TIME = 10.1 MIN. TOTAL FUEL USED = 2730 LB
CONSTANT MACH DESCENT TO 350 KEAS
LEVEL DECEL TO 350 KEAS
MIL PWR
MAX A/B
NOTE:
WHEN AT A SPEED LESS THAN 350 KNOTS, DESCEND IN MAX A/B AT CONSTANT MACH NUMBER TO 350 KEAS. DESCEND AT 350 KEAS.
WHEN AT A HIGHER SPEED THAN 350 KNOTS, DECELERATE AT CONSTANT ALTITUDE AT THE SAME POWER AS THE DESCENT. DESCEND AT 350 KEAS.
ALTITUDE - THOUSANDS OF FEET
DISTANCE - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB
SINGLE ENGINE DESCENT SUMMARY
ARMY STANDARD ATMOSPHERE
MEAN TROPIC DAY
350 KEAS
MIL PWR, MAX A/B AND MAX A/B
22,000 TO 30,000 LB INITIAL GROSS WEIGHT
NOTE: NO SPEED OR RANGE PENALTIES INCLUDED

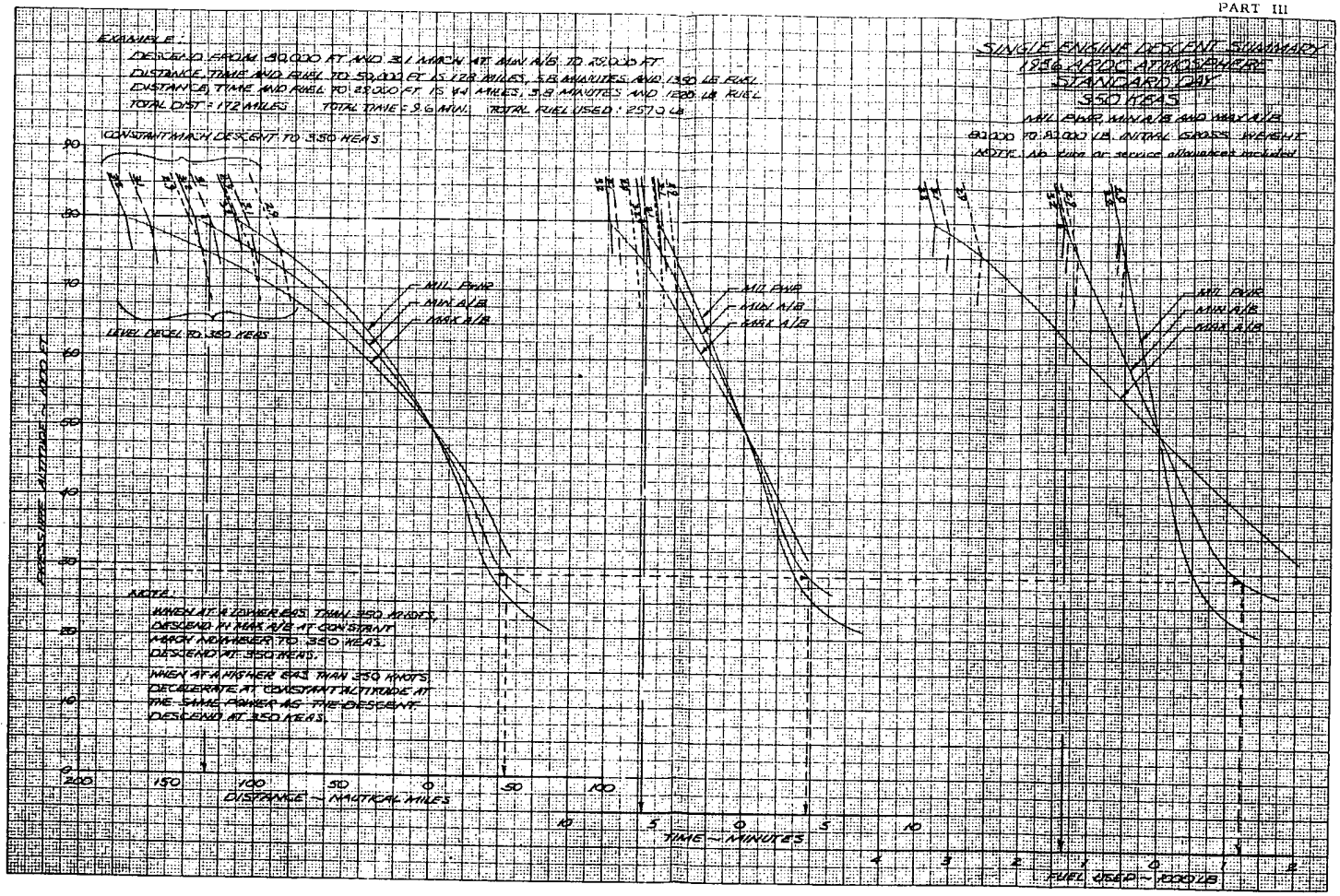

EXAMPLE:
DESCEND FROM 30,000 FT AND .81 MACH AT MAX A/B TO 25,000 FT
DISTANCE, TIME AND FUEL TO 50,000 FT IS 128 MILES, 5.8 MINUTES AND 1350 LB FUEL
DISTANCE, TIME AND FUEL TO 25,000 FT IS 44 MILES, 3.8 MINUTES AND 1220 LB FUEL
TOTAL DIST = 172 MILES TOTAL TIME = 9.6 MIN. TOTAL FUEL USED = 2570 LB
CONSTANT MACH DESCENT TO 350 KEAS
LEVEL DECEL TO 350 KEAS
MIL PWR
MAX A/B
NOTE:
WHEN AT A LOWER EAS THAN 350 KNOTS, DESCEND IN MAX A/B AT CONSTANT MACH NUMBER TO 350 KEAS. DESCEND AT 350 KEAS.
WHEN AT A HIGHER EAS THAN 350 KNOTS, DECELERATE AT CONSTANT ALTITUDE AT THE SAME POWER AS THE DESCENT. DESCEND AT 350 KEAS.
DISTANCE — NAUTICAL MILES
TIME — MINUTES
FUEL USED — 1000 LB
SINGLE ENGINE DESCENT STANDARD
1956 ARDC ATMOSPHERE
STANDARD DAY
350 KEAS
MIL PWR, MIN A/B AND MAX A/B
61,000 TO 81,000 LB. INITIAL GROSS WEIGHT
NOTE: NO FUEL OR SERVICE ALLOWANCE INCLUDED

Figure A3-21

SINGLE ENGINE DESCENT

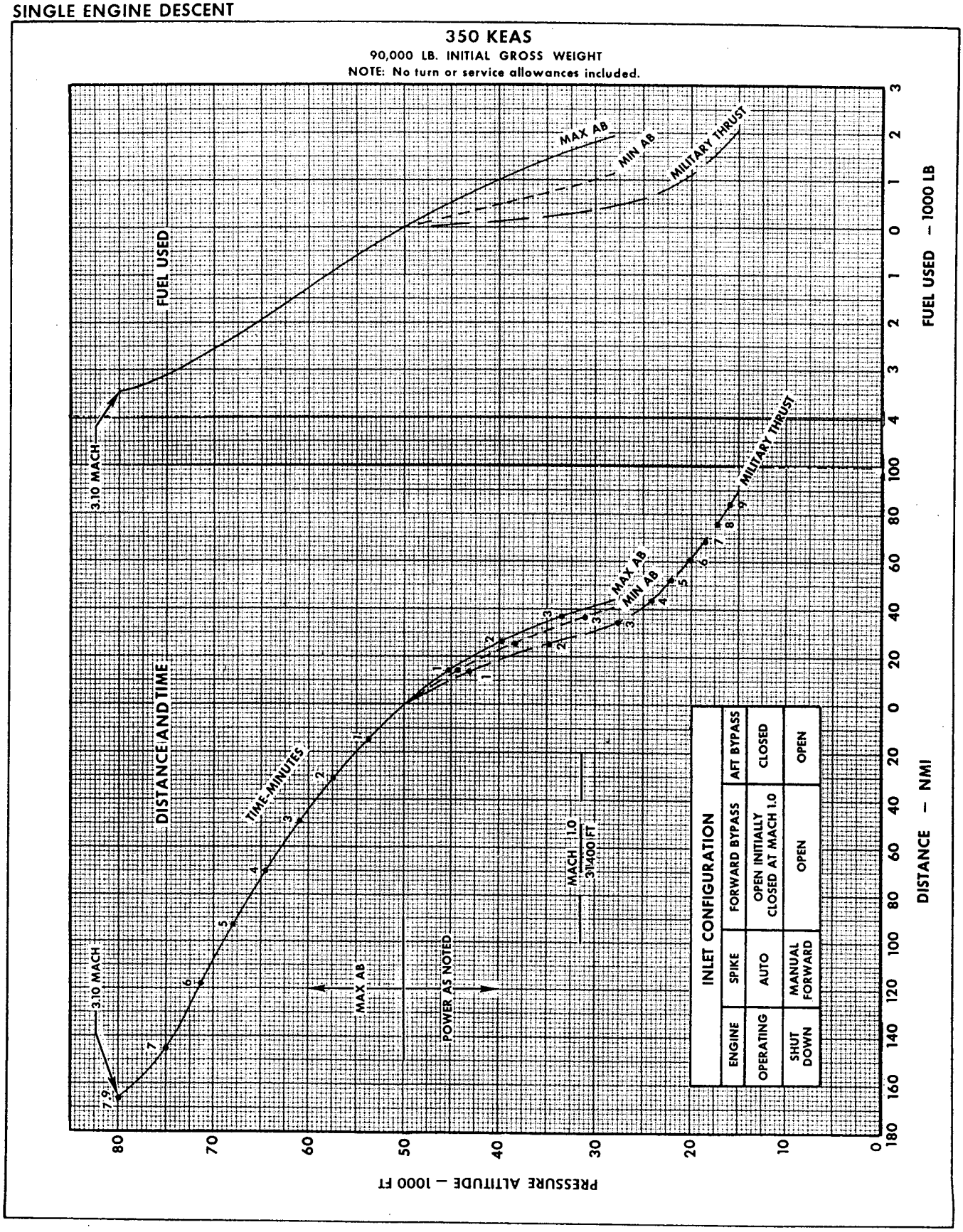


Figure A3-22

SINGLE ENGINE DESCENT

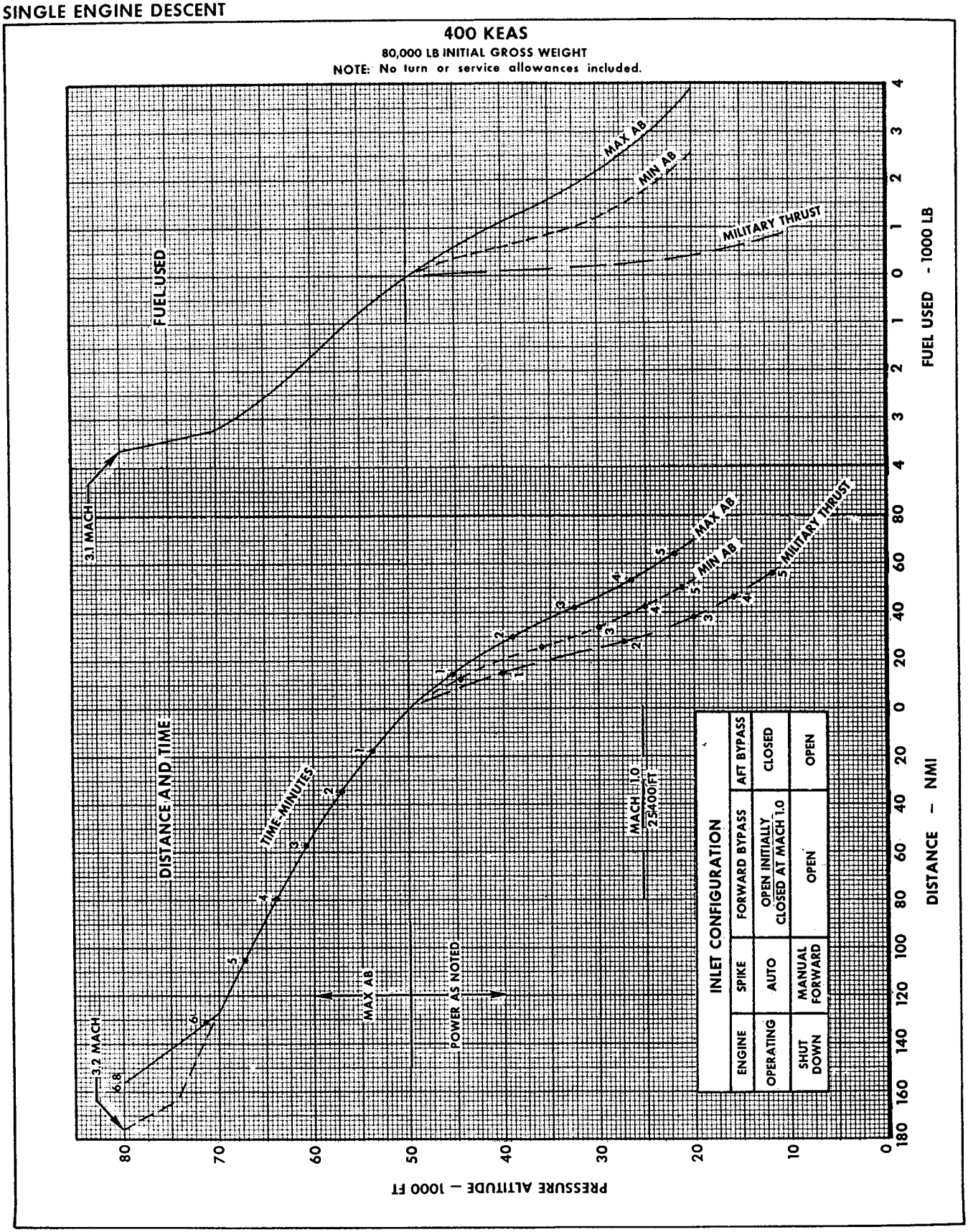


Figure A3-23

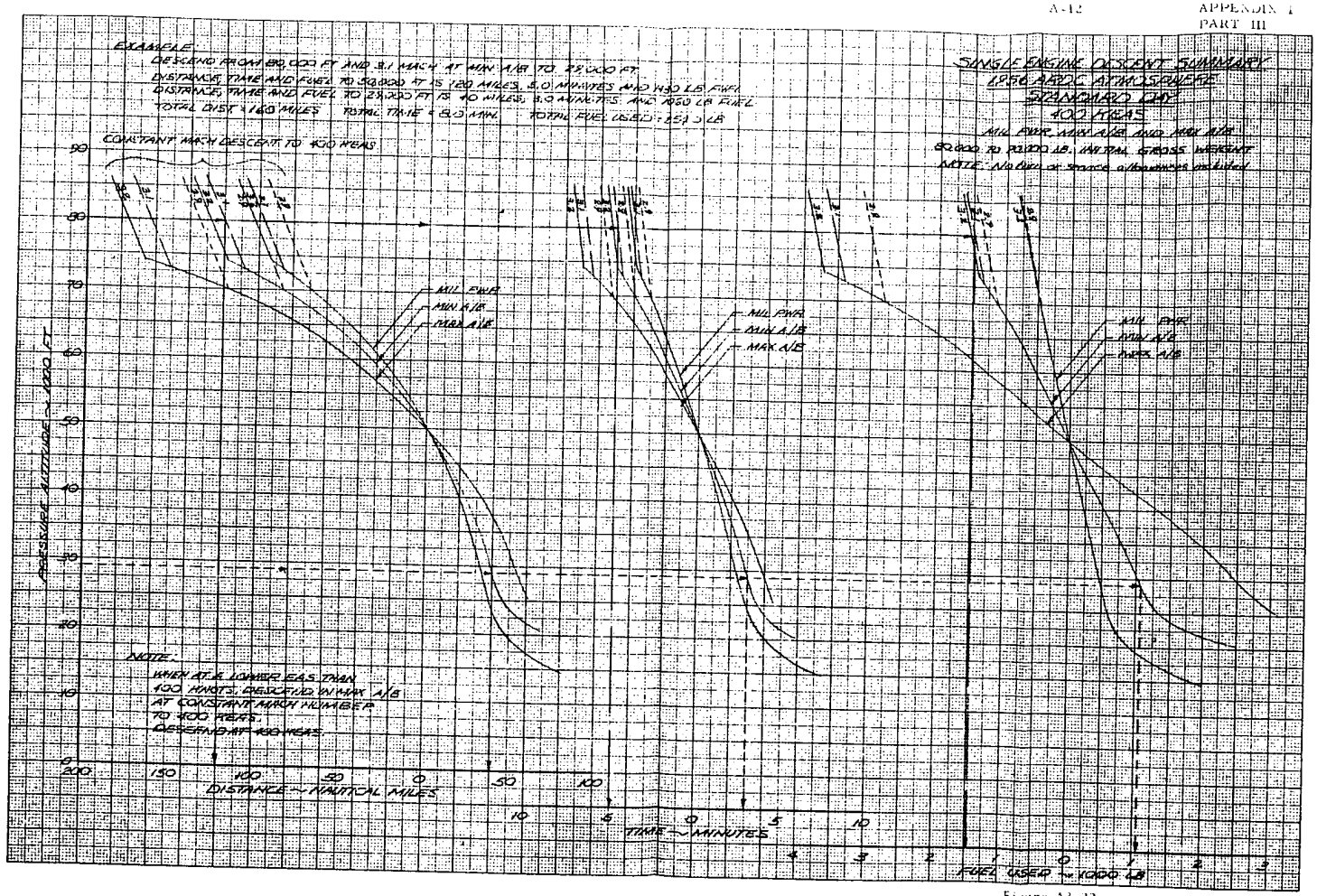

EXAMPLE:
DESCEND FROM 80,000 FT AND 3.1 MACH AT MIN A/B TO 29,000 FT.
DISTANCE, TIME AND FUEL TO 50,000 FT IS 120 MILES, 5.0 MINUTES AND 1430 LB FUEL
DISTANCE, TIME AND FUEL TO 29,000 FT IS 40 MILES, 3.0 MINUTES AND 1050 LB FUEL
TOTAL DIST = 160 MILES TOTAL TIME = 8.0 MIN. TOTAL FUEL USED = 2530 LB
CONSTANT MACH DESCENT TO 400 KEAS
SINGLE ENGINE DESCENT SUMMARY
1956 ARDC ATMOSPHERE
STANDARD DAY
400 KEAS
MIL PWR, MIN A/B AND MAX A/B
80,000 TO 70,000 LB. INITIAL GROSS WEIGHT
NOTE: No fuel or service allowances included
MIL PWR
MIN A/B
MAX A/B
NOTE:
WHEN AT A LOWER EAS THAN 400 KNOTS, DESCEND IN MAX A/B AT CONSTANT MACH NUMBER TO 400 KEAS.
DESCEND AT 400 KEAS.
PRESSURE ALTITUDE ~ 1000 FT
DISTANCE ~ NAUTICAL MILES
TIME ~ MINUTES
FUEL USED ~ 1000 LB

Figure A3-22

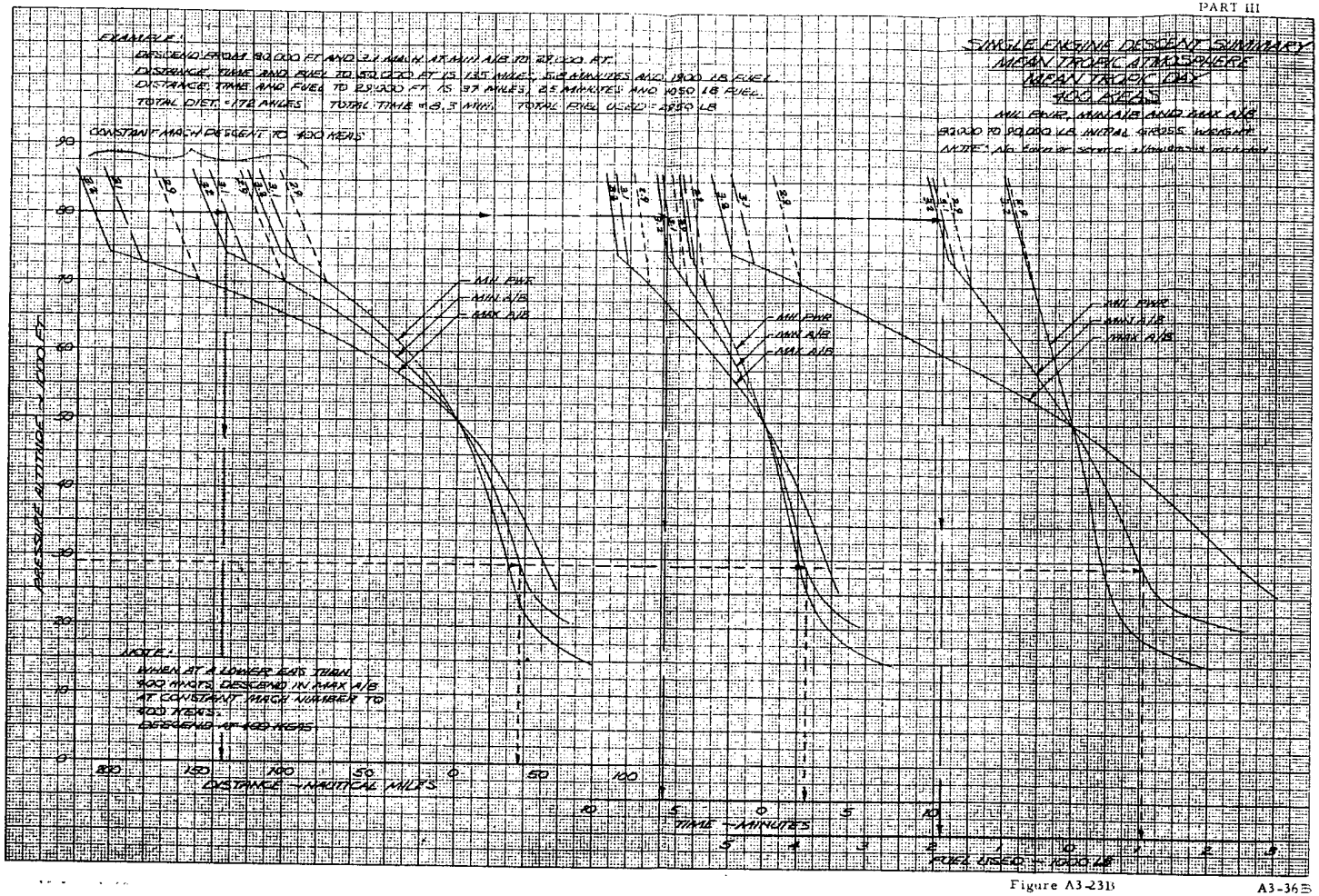
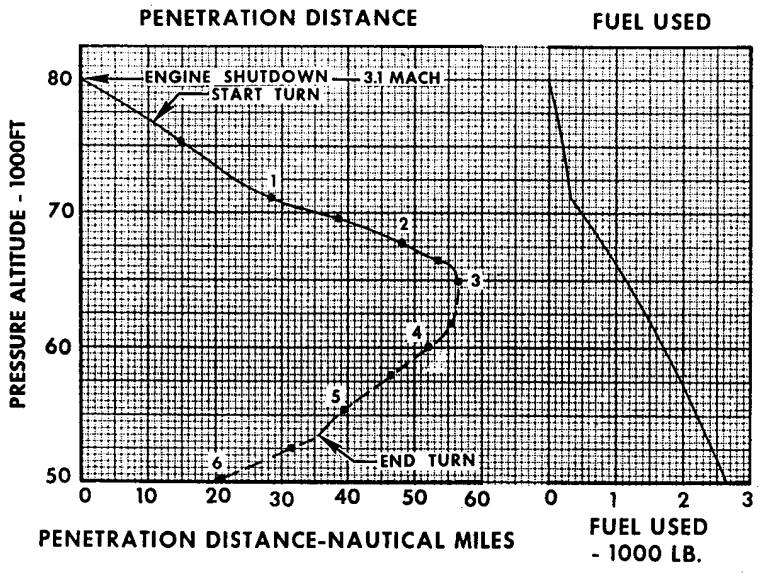

SINGLE ENGINE DESCENT SUMMARY
MEAN TROPICAL ATMOSPHERE
MEAN TAKEOFF DAY
400 KEAS
ANY CRUISE, MAX A/B AND MAX A/B
92000 TO 80000 LB INITIAL GROSS WEIGHT
EXAMPLE:
DESCEND FROM 80,000 FT AND .7 MACH AT MAX A/B TO 22,000 FT.
DISTANCE, TIME AND FUEL TO 60,000 FT IS 135 MILES, 5.9 MINUTES AND 1900 LB FUEL
DISTANCE, TIME AND FUEL TO 29,000 FT IS 37 MILES, 2.5 MINUTES AND 1050 LB FUEL
TOTAL DIST. = 172 MILES TOTAL TIME = 8.3 MIN. TOTAL FUEL USED = 2950 LB
CONSTANT MACH DESCENT TO 400 KEAS
MIL PWR
MIN A/B
MAX A/B
NOTE:
WHEN AT A LOWER ALT THAN 400 KNOTS DESCEND IN MAX A/B AT CONSTANT MACH NUMBER TO 400 KEAS.
DESCEND AT 400 KEAS
PRESSURE ALTITUDE - 1000 FT.
DISTANCE - NAUTICAL MILES
TIME - MINUTES
FUEL USED - 1000 LB

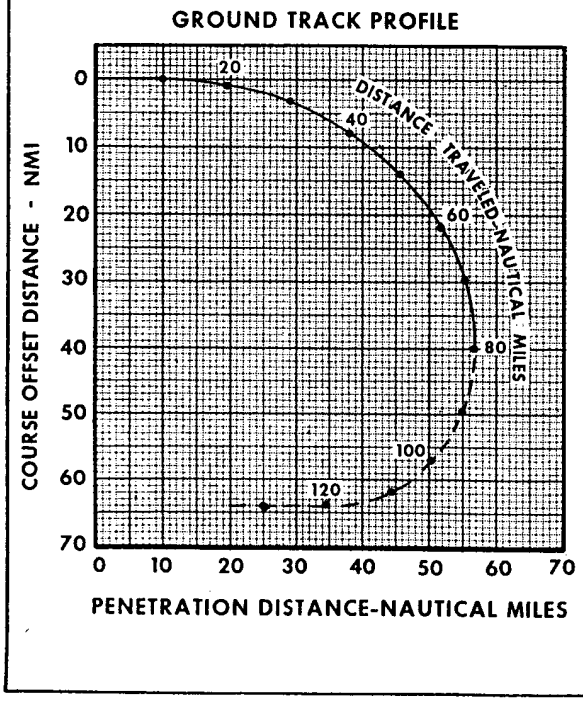
Figure A3-23B

SINGLE ENGINE TURNING DESCENT

MAXIMUM AB-350 KEAS-80,000 FT. TO 50,000 FT.
35 DEG. BANK-180 DEG. TURN
90,000 LB. INITIAL GROSS WEIGHT
NOTE: No service allowance included.



INLET CONFIGURATION			
ENGINE	SPIKE	FORWARD BYPASS	AFT BYPASS
OPERATING	AUTO	OPEN INITIALLY CLOSED AT MACH 1.0	CLOSED
SHUT DOWN	MANUAL FORWARD	OPEN	OPEN



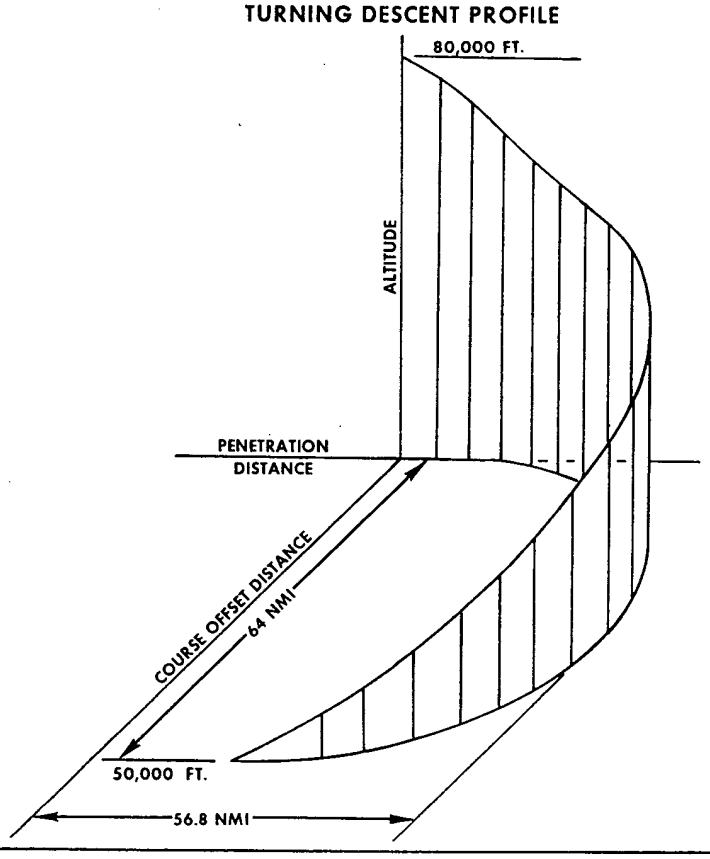


Figure A3-24

PART IV

SUBSONIC CRUISE PERFORMANCE

List of Illustrations

Title — Figure No.

TWO ENGINE OPERATION

Subsonic Long Range Cruise A4-1
Subsonic Maximum Range Cruise Climb - Mach 0.88 ..... A4-2
Maximum Subsonic Specific Range Summary A4-3
Subsonic Range Factor Summary A4-4
Buddy Mission Cruise - Mach 0.77 and 28,000 ft A4-5
Subsonic Specific Range - Mach 0.77 ..... A4-6
Loiter Performance A4-7
Specific Range - 10,000 ft A4-8
Specific Range - 15,000 ft A4-9
Specific Range - 20,000 ft A4-10
Specific Range - 22,000 ft A4-11
Specific Range - 24,000 ft A4-12
Specific Range - 26,000 ft A4-13
Specific Range - 28,000 ft A4-14
Specific Range - 30,000 ft A4-15
Specific Range - 32,000 ft A4-16
Specific Range - 34,000 ft A4-17
Specific Range - 36,000 ft A4-18
Specific Range - 38,000 ft A4-19
Specific Range - 40,000 ft A4-20

SINGLE ENGINE OPERATION

Long Range Cruise - Afterburner Operation A4-21
Long Range Cruise - Military Thrust A4-22
Specific Range - Military Thrust A4-23
Single Engine Cruise Tabulation - Afterburner & Military A4-24

INTRODUCTION

This part of the appendix supplies two engine cruise and loiter performance data and single engine cruise performance data. The material for two engine operation includes a long range cruise chart, maximum specific range summaries for long range cruise-climb and KC-135 buddy missions, loiter performance, and specific range charts for altitudes from 10,000 feet to 40,000 feet. The single engine data show cruise climb range capability with and without afterburner, and a specific range chart for operation at Military thrust.

TWO ENGINE OPERATION

The two engine performance data applies to operation with YJ or YJ-1 engines when aircraft c.g. is at 25% MAC. Operation at more forward c.g. conditions reduces specific range 1% for each one percent shift in c.g., as noted on the specific range charts.

LONG RANGE CRUISE SUMMARY

Figure A4-1 presents the constant altitude, maximum range cruise climb, and Military thrust cruise climb capability of the aircraft in terms of distance to go to 65,000 lbs gross weight (approximately 10,000 lbs fuel remaining). The additional distance available to lower gross weights is also provided. Cruise speeds for constant altitude cruise are tabulated on the chart. The chart can be used on an incremental basis for any desired start and end cruise condition.

Example:

Determine the range available at 25,000 feet, 30,000 feet, and by cruise climbing with an initial gross weight of 120,000 lb if cruise is to be terminated at 10,000 lbs fuel remaining (approximately 65,000 lbs gross weight). Figure A4-1 shows that by cruising at 25,000 feet the range will be 1700 nmi. This range increases to 1810 nmi by cruising at 30,000 feet. Maximum range is available by cruise climbing at 0.88 Mach number. Under this condition cruise would be initiated at 29,400 feet and ended at 41,900 feet at 10,000 lbs fuel remaining. Distance traveled would be 1900 nmi.

MAXIMUM RANGE CRUISE CLIMB

Figure A4-2 presents the distance available to 65,000 lbs gross weight (approximately 10,000 lb fuel remaining) for maximum range cruise climb at 0.88 Mach number and 382,000 lb W/δ. The chart can be used on an incremental basis for any desired start and end cruise condition.

MAXIMUM SUBSONIC SPECIFIC RANGE SUMMARY

Figure A4-3 presents the maximum specific range summary for cruise climb at various Mach numbers. Note that the optimum cruise climb occurs at Mach 0.88. This summary is obtained from the subsonic range factor chart, figure A4-4, by the equations Range Factor (instantaneous) = Specific Range (instantaneous) x W (instantaneous) and δ (and its corresponding pressure altitude) = $W/W/\delta$. (Refer to section on equations).

RANGE FACTOR

Figure A4-4 presents the subsonic range factor for long range cruise climb at any Mach number. The chart shows there is a range factor and corresponding cruise climb schedule (W/δ) for a given cruise Mach number. This provides a quick means for calculating best range available for any given cruise Mach. The chart also shows that the optimum range factor (3100 lb-nmi/lb) occurs at Mach 0.88 and the corresponding cruise climb schedule (W/δ) is 382,000 lb.

Definition of Terms

W/δ = Weight/pressure ratio, lb

W = Aircraft gross weight, lb

δ = Pressure ratio, P/P_o, for the flight pressure altitude (figure A1-8)

W_F = Total fuel flow, lb per hour

KTAS = True airspeed, knots

Ln = Natural logarithm

Equations

$$\text{Specific Range (avg)} = \frac{\text{Distance flown}}{\text{Fuel Used}}, \frac{\text{nmi}}{\text{lb}}$$

Specific Range (instantaneous) = $\frac{KTAS}{W_F}$, $\frac{nmi}{lb}$

Range Available = Specific Range (avg) x Fuel Used, nmi

Range Factor (avg) = Specific Range (avg) x W (avg), $\frac{nmi}{lb}$ x lb

Range Factor (instantaneous) = Specific Range (instantaneous) x W (instantaneous), $\frac{nmi}{lb}$ x lb, or $(\frac{KTAS}{W_F} \times W)$

Range Available = $\frac{\text{Range Factor (avg) x}}{\text{W (avg)}}$

Fuel Used, nmi

Range Available = Range Factor (avg) x ln $(\frac{\text{initial W}}{\text{final W}})$, nmi

or Range Factor (avg) = $\frac{\text{Distance flown}}{\ln(\frac{\text{initial W}}{\text{final W}})}$,

lb x $\frac{nmi}{lb}$

$\delta = \frac{W}{W/\delta}$

Example (1):

Determine the range available and the cruise climb schedule for cruise at 0.80 Mach. (Note that this is not the optimum cruise speed.) The initial cruising weight is 100,000 lb, and 20,000 lb of fuel are to be used. Assume a standard day with zero wind.

a. Average gross weight is 90,000 lb.

b. From figure A4-4, at Mach 0.80, the cruise climb schedule (W/δ) is 275,000 lb and the range factor is 2915 lb - nmi/lb.

c. The range available = (2915 x 20,000/90,000) = 648 nmi.

d. The initial pressure ratio, δ, = (100,000/275,000) = 0.3636.

The final pressure ratio, δ, = (80,000/275,000) = 0.2929.

e. Enter the standard atmosphere table, figure A1-8, with the initial and final pressure ratios, and determine the approximate initial and final cruise altitudes as 25,500 ft and 30,500 feet, respectively.

Example (2):

Determine the cruise fuel required and cruise climb schedule for cruise at 0.75 Mach. The planned cruise distance is 650 nmi. Assume a standard day with zero wind. Planned initial cruise gross weight is 100,000 lb.

a. From figure A4-4, at Mach 0.75, the cruise climb schedule (W/δ) is 227,000 lb and the range factor is 2730 lb - nmi/lb.

b. From section on equations, $\ln \frac{W\text{ (initial)}}{W\text{ (final)}} = \frac{\text{Distance}}{\text{Range Factor}}$; $\ln \frac{100,000}{W\text{ (final)}} = \frac{650}{2730}$, or 0.2380; $\frac{100,000}{W\text{ (final)}} = 1.269$; W (final) = (100,000/1.269) = 78,800 lb.

Therefore, cruise fuel required = (100,000 - 78,800) = 21,200 lb.

c. Using the same method as in the previous example, the approximate initial and final cruise altitudes are 21,000 feet and 26,500 feet, respectively.

BUDDY MISSION CRUISE

Figure A4-5 presents the distance available to 65,000 lbs gross weight (approximately 10,000 lb fuel remaining) for Buddy Mission cruise at Mach 0.77 and 28,000 feet. The speed and altitude schedule is compatible with KC-135 tanker performance characteristics. The chart can be used on an incremental basis for any desired start and end cruise condition.

SPECIFIC RANGE - MACH 0.77

Figure A4-6 presents specific range data at Mach 0.77. The Buddy Mission altitude is listed on the chart. If desired, greater range is obtained by cruise climbing.

LOITER PERFORMANCE

Figure A4-7 presents loiter performance as minutes per 1000 lb of fuel used. The recommended speed schedule is listed in the chart.

Example:

Determine the loiter time available at 20,000 feet for an initial gross weight of 70,000 lb. A planned 10,000 lb of fuel is to be consumed. Enter figure A4-7 at 70,000 lbs gross weight and 20,000 feet and read 5.09 minutes per 1000 lb of fuel. Reenter at 60,000 lbs and 20,000 feet and read 5.62 minutes per 1000 lb of fuel. The average value is 5.35 minutes per 1000 lb of fuel. This provides 53.5 minutes for the planned 10,000 lbs of fuel consumption.

SPECIFIC RANGE - CONSTANT ALTITUDE

The specific range charts (figures A4-8 thru A4-15) present cruise data for various constant altitudes (from 10,000 ft to 40,000 ft) throughout the speed range from maximum endurance to Military thrust. Each chart presents nautical miles per 1000 lb of fuel (nmi/Klb) as a function of Mach number and gross weight with subscales of KEAS and KTAS for standard day. Also included are an overlay grid of fuel flow per engine, the maximum range speed schedule, and the recommended loiter speed schedule.

SINGLE ENGINE OPERATION

The single engine performance data applies to operation with YJ engines. A five percent service allowance is included. Refer to text for other items affecting the performance results. The long range cruise data for both Military and Afterburner operation can be used in conjunction with the single engine descent information in Part III. Transition from end of descent (as indicated in the single engine descent curves) to start of single engine cruise is accomplished by drift down. Duration of drift down is indeterminate and is largely dependent on piloting technique. Drift down consists of a slow sink period during which fuel economy is above the corresponding cruise values for the same weight as long as the actual altitude is above the scheduled cruise altitude. The difference in miles per pound can be neglected in planning and provides an operational contingency pad. Refer to Section III for fuel management during single engine cruise.

LONG RANGE CRUISE - AFTERBURNER OPERATION

Figure A4-21 presents single engine long range cruise performance for afterburner operation in terms of distance to go to 60,000 lbs gross weight (approximately 5000 lbs fuel remaining). The chart is based on zero wind distance without turns at test day conditions. Test EGT was trimmed between 780°C and 810°C for CIT range of -20°C to +20°C. The long range

PART V

SUPERSONIC CRUISE PERFORMANCE

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Mach 3.20		
Specific Range, Ambient Temp.	-66.5°C	A5-2
" " " "	-56.5°C	A5-3
" " " "	-53.0°C	A5-4
" " " "	-43.0°C	A5-5
Long Range Cruise - 1956 ARDC Atmosphere		
Fuel and Time Profile	Sheet 1 of 3 .	A5-6
Climb - Cruise Intercept Points	Sheet 2 of 3 .	
Cruise Performance	Sheet 3 of 3 .	
High Altitude Cruise - 1956 ARDC Atmosphere		
Fuel and Time Profile	Sheet 1 of 3 .	A5-7
Climb - Cruise Intercept Points	Sheet 2 of 3 .	
Cruise Performance	Sheet 3 of 3 .	
Maximum A/B Ceiling Cruise Profile	Sheet 1 of 2 .	A5-8
(With STD DAY climb)	Sheet 2 of 2 .	
Long Range Cruise - MEAN TROPIC Atmosphere		
Fuel and Time Profile	Sheet 1 of 3 .	A5-9
Climb - Cruise Intercept Points	Sheet 2 of 3 .	
Cruise Performance	Sheet 3 of 3 .	
High Altitude Cruise - MEAN TROPIC Atmosphere		
Fuel and Time Profile	Sheet 1 of 3 .	A5-10
Climb - Cruise Intercept Points	Sheet 2 of 3 .	
Cruise Performance	Sheet 3 of 3 .	
Maximum A/B Ceiling Cruise Profile	Sheet 1 of 2 .	A5-11
(With MEAN TROPIC climb)	Sheet 2 of 2 .	
Mach 3.10		
Specific Range, Ambient Temp.	-64.7°C	A5-12
" " " "	-56.5°C	A5-13
" " " "	-53.0°C	A5-14
" " " "	-43.5°C	A5-15
Long Range Cruise - 1956 ARDC Atmosphere		
Fuel and Time Profile	Sheet 1 of 3 .	A5-16
Climb - Cruise Intercept Points	Sheet 2 of 3 .	
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High Altitude Cruise - 1956 ARDC Atmosphere		
Fuel and Time Profile	Sheet 1 of 3 .	A5-17
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Title		Figure No.
High Altitude Cruise - MEAN TROPIC Atmosphere		
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Maximum A/B Ceiling Cruise Profile	Sheet 1 of 2 .	A5-21
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Mach 2.90		
Specific Range, Ambient Temp. -66.0°C		A5-22
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" " " " -53.0°C		A5-24
" " " " -42.5°C		A5-25
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Rapid Deployment to ARCP - 1956 ARDC Atmosphere		A5-29
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Profile of Rapid Deployment to ARCP	Sheet 1 of 2 .	A5-32
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TURNING PERFORMANCE

Figure A5-1 presents generalized turning performance at constant Mach numbers for various ambient temperatures and bank angles. Turn radius, distance, and time are plotted for a selected range of Mach numbers, ambient temperatures, bank angles, and degrees of turn.

Example:

For a Mach 3.00 turn at a forecast ambient temperature of -56.5°C, 30° bank angle, and a planned 180° of turn, find the turn radius, distance, and time. As shown in the chart, enter figure A5-1 at Mach 3.00 and -56.5°C ambient temperature and note that true airspeed is 1720 knots. Proceed horizontally to 30° bank angle and read turn radius as 74.5 nautical miles. Proceed downward to 180° of turn and read turn distance as 235 nautical miles flown. Proceed horizontally to 1720 KTAS and read the turn time as 8.1 minutes.

SPECIFIC RANGE

Specific range charts are presented for speeds of Mach 3.20, 3.10, and 2.90 and for four ambient temperature conditions at each speed as shown by the list of illustrations. The data is computed from Flight Test and Operational Testing results with YJ-1 engines. Corrections for a range of bank angles are included on each chart to show the effect bank angle has on specific range and altitude capability while turning. Supplemental scales provide KEAS-altitude information and fuel flow conversions.

Example:

Refer to figure A5-13, Specific Range data for Mach 3.10 cruise at -56.5°C ambient temperature. Locate the Max Range cruise schedule line. At long range cruise power and 80,000 pounds gross weight the cruise climb altitude is 78,150 feet and the zero bank angle specific range is 61.0 nmi/1000 lb of fuel. For a turn at the same power setting, using a 30 degree bank angle, the specific range is 53.0 nmi/1000 lb of fuel and the altitude is 75,100 feet. The fuel flow per engine is 14,600 lb/hr at zero bank and 16,800 lb/hr at 30 degree bank for a -56.5°C ambient temperature day. At this temperature, Mach 3.1 corresponds to 1777 KTAS as listed in the chart.

LONG RANGE AND HIGH ALTITUDE CRUISE SUMMARIES

Long range cruise summaries are presented for Mach 3.20, 3.10, and 2.90. High altitude cruise summaries are presented for Mach 3.20 and 3.10. The high altitude profiles are based on the "90%" lines shown on the Specific Range charts, except that the performance shown conforms with the present 85,000 ft altitude restriction. These data are presented for both the 1956 ARDC Atmosphere and the "MEAN TROPIC" Atmosphere as shown in the list of illustrations. The climb and cruise data are computed from Flight Test and Operational Testing results with YJ-1 engines. Descent data is based on Flight Test and Operational testing at near standard temperatures. There are three sheets for each figure. The first sheet provides cruise summaries showing distance and time from end AR at 30,000 feet through the climb, cruise, and descent to 20,000 feet with either 5000 lbs or 7500 lbs of fuel reserve. The second sheet presents climb-cruise intercepts which are to be used in conjunction with sheet 3. The third sheet presents performance and flight planning data. The initial conditions shown are end AR at 30,000 feet, and brake release with either 64,000 lbs or 50,000 lbs fuel remaining using the normal climb schedule. The effect of various temperatures is shown for climb and cruise performance. The descent performance shown is based on operational testing and does not include the effect of temperature. Descent through a "Tropic" atmosphere may be approximated by increasing the presented descent data by the following increments:

Distance - 30 miles

Time - 1 minute

Fuel used - 100 pounds

Use of the chart is illustrated by the following example:

Example:

Refer to figure A5-7, sheet 2 of 3 and sheet 3 of 3.

Find the total distance capability and time required for a Mach 3.2 high altitude cruise with a forecast ambient temperature condition of -56.5°C at cruise. A profile is planned consisting of a heavyweight takeoff at sea level with standard day climb, cruise without turn, normal descent, and 7500 lb fuel reserve at 20,000 feet. Planned fuel load at brake release is 64,000 lb.

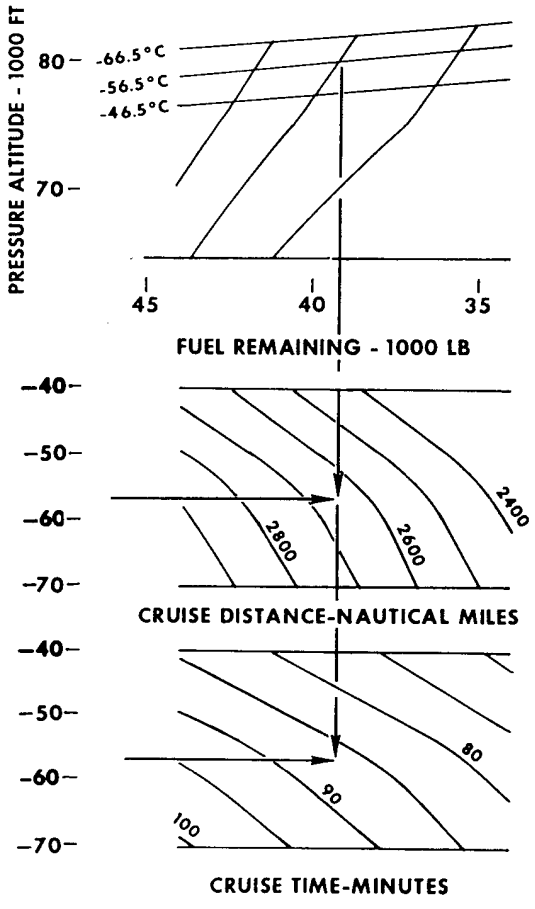
Enter figure A5-7, sheet 2 of 3, at 119,150 lb gross weight, sea level altitude, standard day climb temperature, and -56.5°C cruise temperature and read the cruise-climb intercept as 80,100 feet. Read climb distance as 345 miles, climb time as 20.1 minutes

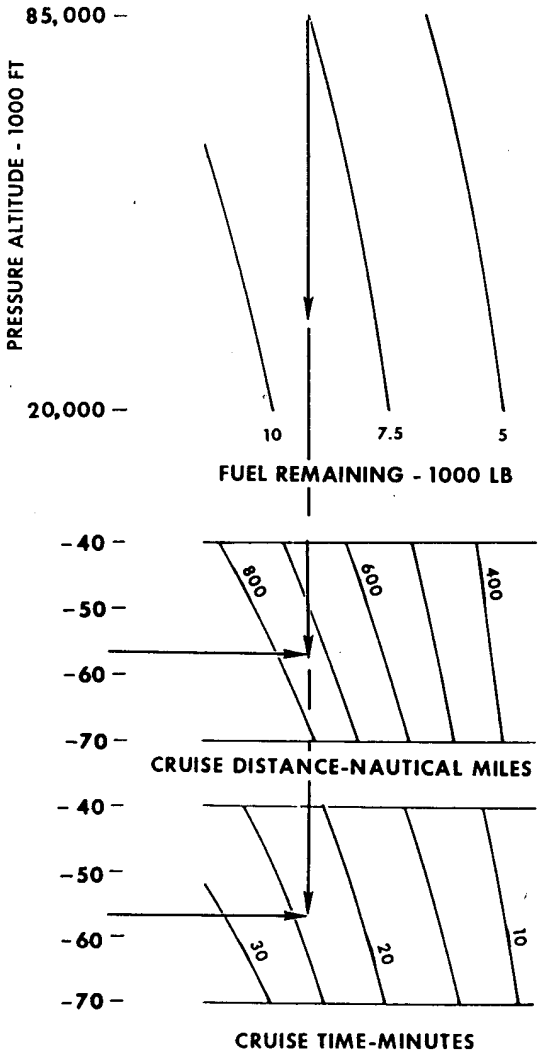
and fuel remaining as 39,250 lb. Referring to figure A5-7, sheet 3 of 3, the intercept of the standard day climb line and the -56.5°C cruise line is shown. The lower portion of sheet 3 of 3 shows cruise distance and cruise time to zero fuel remaining as a function of fuel remaining and cruise reference temperature. Entering the portion of the curve at the fuel remaining value of 39,250 lb and a cruise reference temperature of -56.5°C, read the cruise distance as 2655 miles and cruise time as 86.8 minutes. Then read on the cruise line (from beginning of the 7500 lb descent line) the fuel remaining as 8900 lb. Reading the distance and time to zero fuel remaining, the distance is 740 miles and the time is 24 minutes. This gives the incremental cruise distance as (2655 - 740) = 1915 miles and the cruise time as (86.8 - 24) = 62.8 minutes. The descent to 20,000 ft is 237 miles and 13.8 minutes as shown by the vertical scales at the right side of the profile portion of the chart.

Distance and time from brake release at sea level with 64,000 lb fuel to 20,000 feet with 7500 lb fuel remaining is:

Distance = (345 + 1915 + 237) = 2497 miles

Time = (20.1 + 62.8 + 13.8) = 96.7 minutes





Figures A5-30 and A5-32 (sheet 1 of 2) show standard and tropic day mission profiles for five representative Mach numbers, and portray the climb, cruise and deceleration segments of the missions. Figures A5-30 and A5-32 (sheet 2 of 2) show the corresponding time and fuel remaining for the presented profiles.

Figures A5-29 and A5-31 give the necessary detail information for planning a flight of specific length. These curves present the overall mission time from brake release to ARCP, cruise Mach number, altitude to initiate constant Mach climb, cruise altitude and the DTG to start deceleration to arrive at 29,000 feet at a point 20 miles from the ARCP. Mach 1.25 is the minimum supersonic cruise Mach recommended, as this speed is the "break point" for minimum time between subsonic and supersonic flight plans. For a mission distance of less than 130 miles, the flight should be made at 0.91 Mach. Missions longer than 130 miles would be flown at the Mach number given by figures A5-29 and A5-31.

Example:

To select flight plan for minimum time to ARCP, with Mean Tropic day temperatures, and ARCP 300 miles from takeoff point.

Refer to figure A5-31, "Rapid Deployment to ARCP".

Mission time from brake release to ARCP is 23.5 minutes.

Cruise Mach = 2.31.

Start constant Mach climb = 55,300 feet.

Cruise altitude = 67,000 feet.

DTG at start decel = 117 miles.

MAXIMUM A/B CEILING CRUISE SUMMARIES

Maximum A/B Ceiling Cruise summaries are presented for Mach 3.20 and 3.10 as shown in the list of illustrations. The data were calculated from Flight Test and Operational Testing results with YJ-1 engines. There are two sheets for each figure. The first sheet presents cruise summaries showing distance and time from end AR at 32,000 feet through the climb, cruise, and descent to 20,000 feet with either 5000 lbs or 7500 lbs fuel reserve. The second sheet presents cruise summaries which are indexed at 10,000 lb fuel remaining at altitude (zero distance and time). The initial conditions shown are end AR at 30,000 feet and brake release with 64,000 lbs fuel remaining using the normal climb schedule. Distance and time allowances for reserves of 5000, 7500, and 10,000 lbs at 20,000 feet are shown in the charts. To obtain the total distance and time, add the two distances and times for the desired profile.

Example:

Refer to figure A5-18, sheet 2 of 2, and the example figure on the following page.

Find the total distance and time for a 3.10 Mach maximum A/B ceiling cruise at a forecast ambient temperature of -56.5°C at cruise. A profile is planned consisting of a heavyweight takeoff at sea level with standard day climb, cruise without turns, and 7500 lb reserve at 20,000 feet. Planned fuel load at brake release is 64,000 lb. Enter figure A5-18, sheet 2 of 2, at the climb line for the sea level 64,000 lb fuel remaining case and read distance and time as 1809 nmi, and 1 hr, 09.5 min. Reenter at the 7500 lb reserve descent line at 20,000 feet and read distance and time as 310 nmi and 16.7 min. Add the distances and times and obtain 2114 nmi and 1 hr, 26.2 min.

If forecast temperatures indicate standard day climb and cold day cruise, -64.5°C, the distance will be increased by two small increments. The cruise distance will be longer due to the colder temperature, and the climb distance will be longer due to the climb to higher altitude. Referring to the text illustration below, which is for 119,150 lb gross weight and 64,000 lb fuel remaining at brake release, the shaded triangles show where the standard day climb intercepts the four cruise lines. The cold day intercept shows a distance of 1635 nmi. Extend the climb curve to the altitude where the cold day cruise begins and read a distance of 1475 nmi. The difference between these distances (1635 - 1475 = 160) is the increase in range due to cold day cruise conditions. The corresponding time increment is 4.3 min. for the additional 160 nmi of cruise. This results in a total range and time of 2279 nmi and 1 hr, 30.5 min.

MISSION PLANNING FACTORS TABLE

A Mission Planning Factors Table is provided on figure A5-28 for quick reference in mission planning.

RAPID DEPLOYMENT TO ARCP

Figures A5-29 thru A5-32 present the data for a minimum time profile from brake release to ARCP.

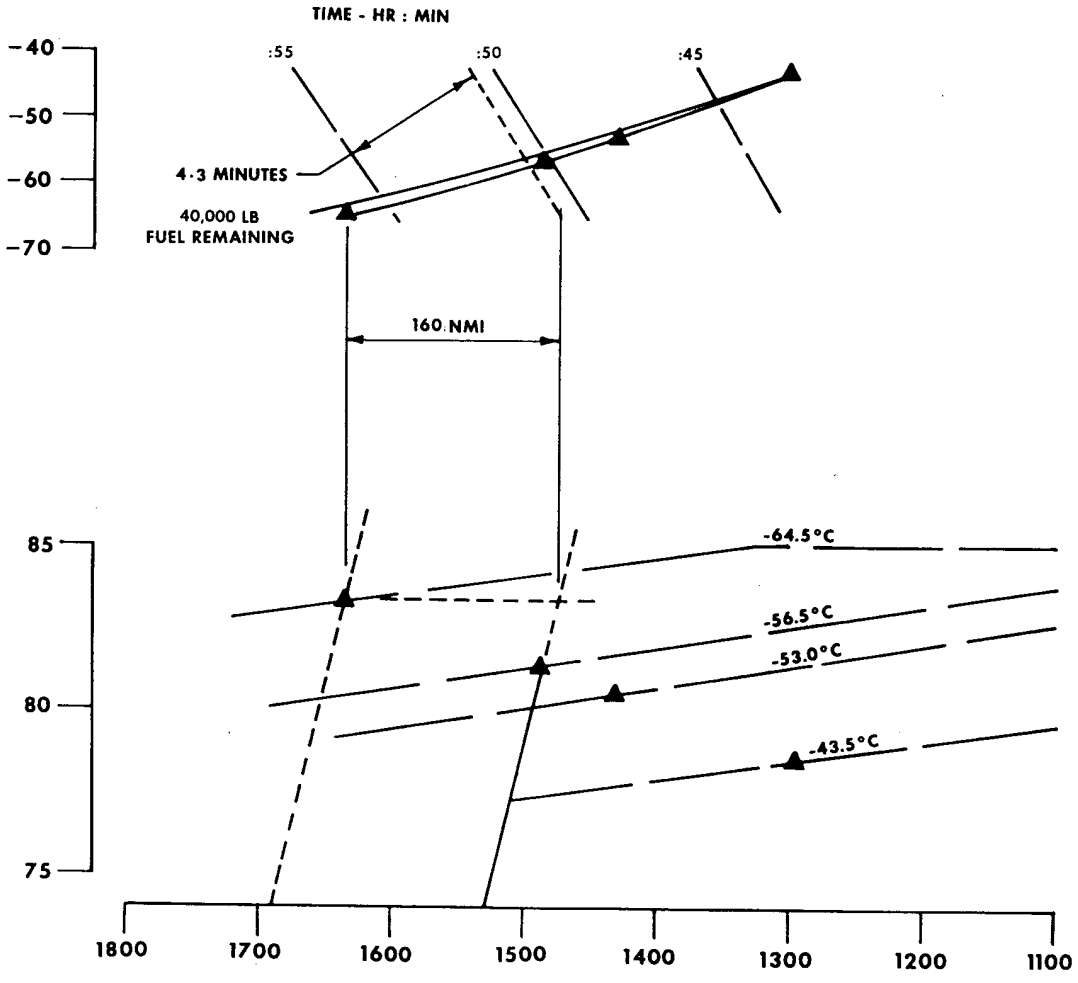
The profile is defined as:

1. 50,000 pounds fuel remaining at brake release.
2. Normal climb schedule to cruise Mach number.
3. Climb to cruise altitude at constant Mach number.
4. Cruise for two minutes at 82° PLA.
5. Normal deceleration to 300 KEAS.
6. Normal 300 KEAS descent to reach 29,000 ft at a point 20 miles from ARCP.

The data are presented for both the 1956 ARDC and Mean Tropic atmospheres.

EXAMPLE FIGURE

REFER TO FIGURE A5-18 SHEET 2 OF 2
AND PAGE A5-4 A



TIME LIMITS

YJT11D-20A and YJ-1 engines may be operated continuously at all ratings when within the normal exhaust gas temperature limits; however, no more than one hour may be accumulated with EGT in excess of the normal limit schedule, and EGT must be reduced immediately if an emergency limit temperature is exceeded. (See EGT Limits and figure 5-2.)

CAUTION

Continuous or accumulated operating time in the emergency EGT operating zone for more than 15 minutes may require engine removal.

EXHAUST GAS TEMPERATURE

The nominal operating band, normal limits and emergency exhaust gas temperature operating schedules are prescribed as a function of compressor inlet temperature as shown in figure 5-2. Limit EGT's for continuous operation are 805°C when compressor inlet temperature is above 60°C, and 845°C when CIT is below 60°C. The setting at which the red warning light on the EGT gage illuminates and the fuel derichment system operates, if armed, is 860°C, a value which is above the normal operating temperature limit schedule.

NOTE

At compressor inlet temperatures below 5°C, the possibility of engine stall exists at EGT's between the maximum permissible value and the nominal operating band.

In the event that emergency engine operation is required, EGT may be increased to 825°C when above 60°C CIT, or to 865°C when below 60°C CIT: however, an accurate accounting of operating time in the emergency operating zone must be maintained.

NOTE

- Any operation in or above the emergency operating zone requires special maintenance action.
- The permissible emergency EGT level at low CIT's is above the derich system actuation point; therefore, the derich system must be disarmed if this level is to be attained.

COMPRESSOR INLET TEMPERATURE

The maximum allowable compressor inlet temperature is 427°C. In addition, deceleration must be monitored so that engine cooling rates will not be excessive. While above an airspeed of Mach 1.8, the aircraft maximum rate of descent should be such that rate of deceleration does not exceed 1.0 Mach in three minutes. There is no limitation on rate of deceleration while below Mach 1.8.

COMPRESSOR INLET PRESSURE

The minimum pressure recommended for airstarts from stabilized windmilling speeds is 7 psi. This pressure is marked by a green radial line.

ENGINE SPEED

Military and afterburning engine speeds are the same and are automatically scheduled by the fuel control as a function of Compressor Inlet Temperature. The normal schedule is shown by figure 5-2. Engine overspeed above 7450 rpm requires a visual inspection of the turbine. Notify the engine manufacturer if 7550 rpm is ever exceeded. Each instance of overspeeding should be reported as an engine discrepancy and should include the maximum rpm attained.

LIMIT FLIGHT SPEED AND ALTITUDE ENVELOPE

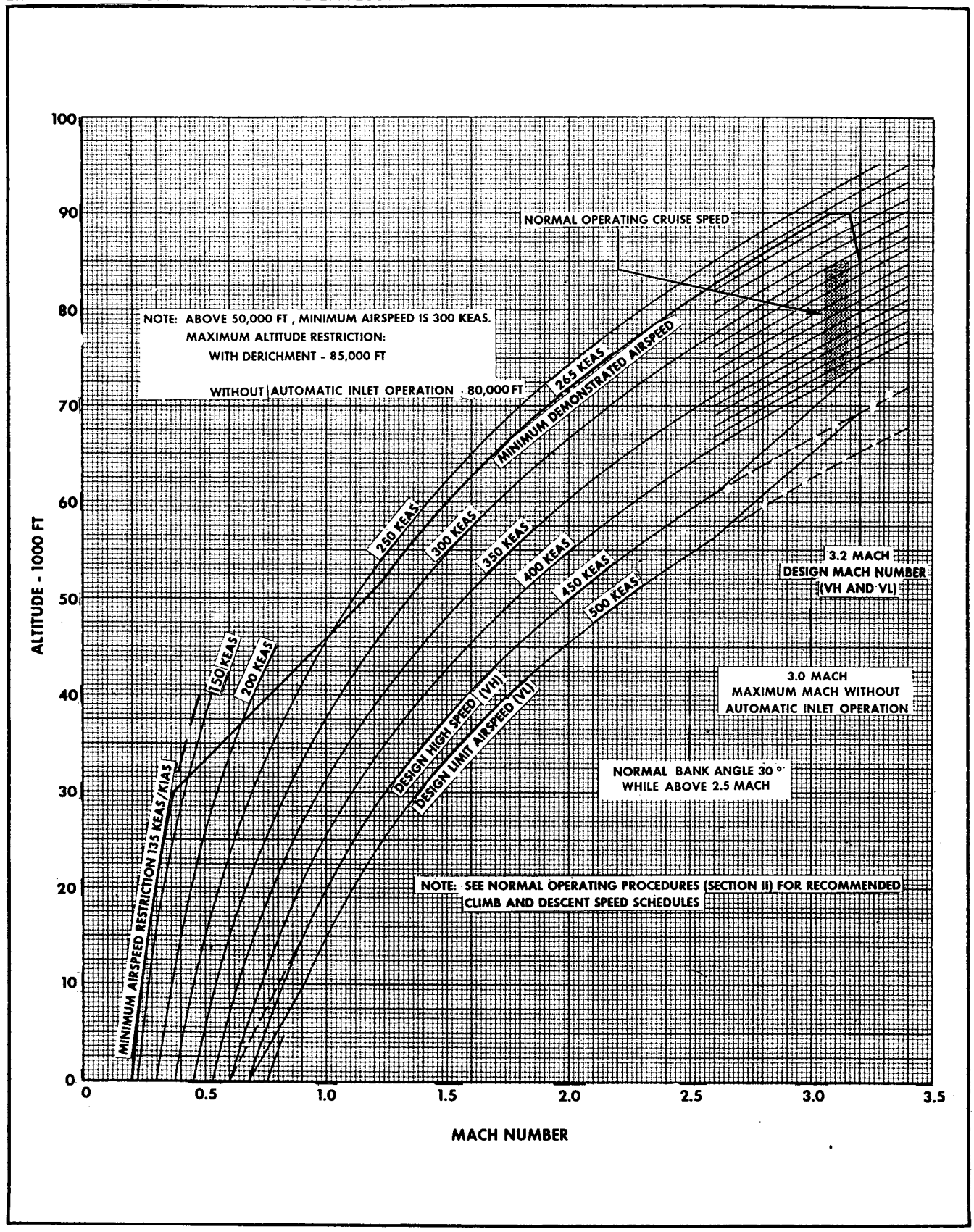


Figure 5-3

FUEL

The approved fuel is PWA 523E. The P&W approved source of lubricity additive, PSJ-67A, must be mixed with the fuel in the ratio of 0.29 gallons per 4000 gallons of fuel. Fuels such as JP-4, JP-5, and JP-6 may be used only for emergency requirements such as air refueling when standard fuel is not available and air refueling must be accomplished or risk loss of the aircraft. Operation with emergency fuels should be restricted to speeds below Mach 1.5.

OIL

The approved oil is PWA 524B. If necessary because of low ambient temperatures, it may be diluted with Trichloroethylene, Federal Specification O-T-634, Type 1, in accordance with Maintenance Manual procedures.

Oil Pressure

Oil pressures below 35 psi are unsafe and require that a landing be made as soon as possible, using minimum thrust required to sustain flight until a landing can be accomplished. Normal oil pressure is from 40 to 55 psi. Except at IDLE throttle settings, oil pressures between 35 psi and 40 psi are undesirable and should be reported after flight. A gradually increasing oil pressure up to 60 psi is acceptable at high Mach numbers provided the indication returns to normal values after aircraft decelerates to subsonic speed.

Oil Temperature

Oil temperature must be at least 60°F (15°C) prior to starting unless previously diluted with Trichloroethylene (PWA 9003). Engine oil temperatures above 290°C are unsafe and a landing should be made as soon as possible if the temperature cannot be maintained below this value. An engine should not be restarted after windmilling at subsonic speed when CIT is less than 15°C (60°F) for more than 5 minutes. If restarted, operation above IDLE with OIL TEMP warning light illuminated shall be as brief as possible.

MAXIMUM WEIGHT LIMITS

Maximum gross weight is not limited except by takeoff performance capabilities. Base maximum takeoff weights on information provided in Part II of the Appendix.

MAXIMUM ALTITUDE

Maximum altitude with derichment installed and operational is 85,000 feet; maximum altitude without derichment is 75,000 feet.

LIMIT AIRSPEEDS

(Refer to figure 5-3 for the limit flight speed and altitude envelope.)

MINIMUM AIRSPEED RESTRICTION

The stall warning light on the annunciator panel and the master caution light illuminate when angle of attack reaches 14° in flight. A tone is also produced in the pilot's headset. When above 135 KIAS, the speed at which stall warning occurs is the minimum airspeed restriction for the existing vehicle weight, c.g., and load factor unless operation is governed by a higher value of minimum KEAS as displayed by the Triple Display Indicator. Minimum airspeed is 300 KEAS above 50,000 feet.

INDICATED AIRSPEED

The Mach-airspeed indicator limit hand is set to indicate airspeed (KIAS) corresponding to 500 KEAS. However, the 500 KEAS limit applies only at altitudes above 9400 feet, and at airspeed below Mach 2.6. Below 9400 feet, limit airspeed decreases linearly with altitude from 500 KEAS at 9400 feet to 450 KEAS at sea level. Above Mach 2.6, limit airspeed decreases linearly from 500 KEAS at Mach 2.6 to 450 KEAS at Mach 3.2. See figure 5-4 for variation of KIAS with altitude for KEAS.

Note

Maximum recommended operating speeds are at least 50 KEAS less than limit airspeeds. 450 KEAS (Mach 0.9) is not recommended below 14,800 feet.

LIMIT AIRSPEED VS ALTITUDE

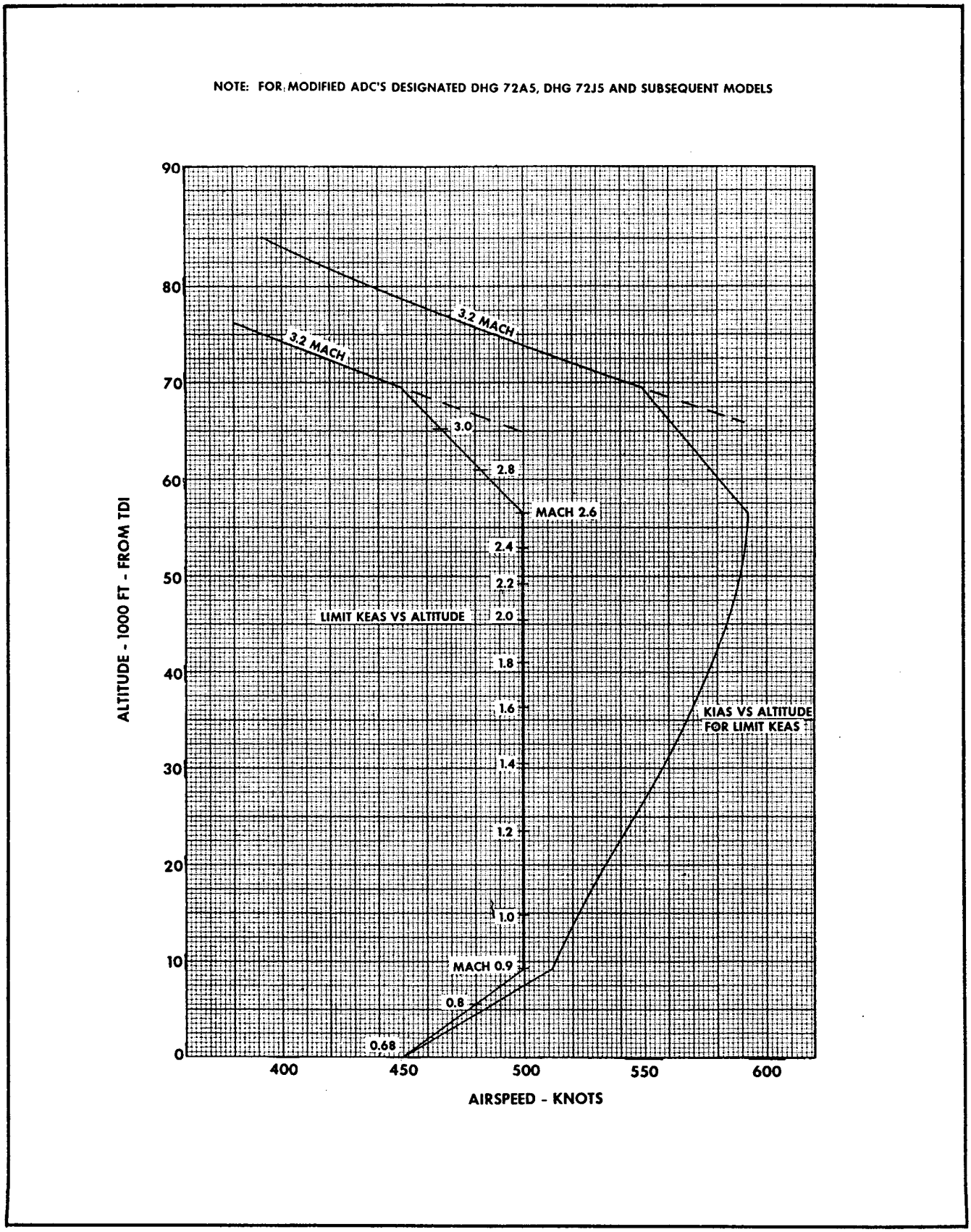
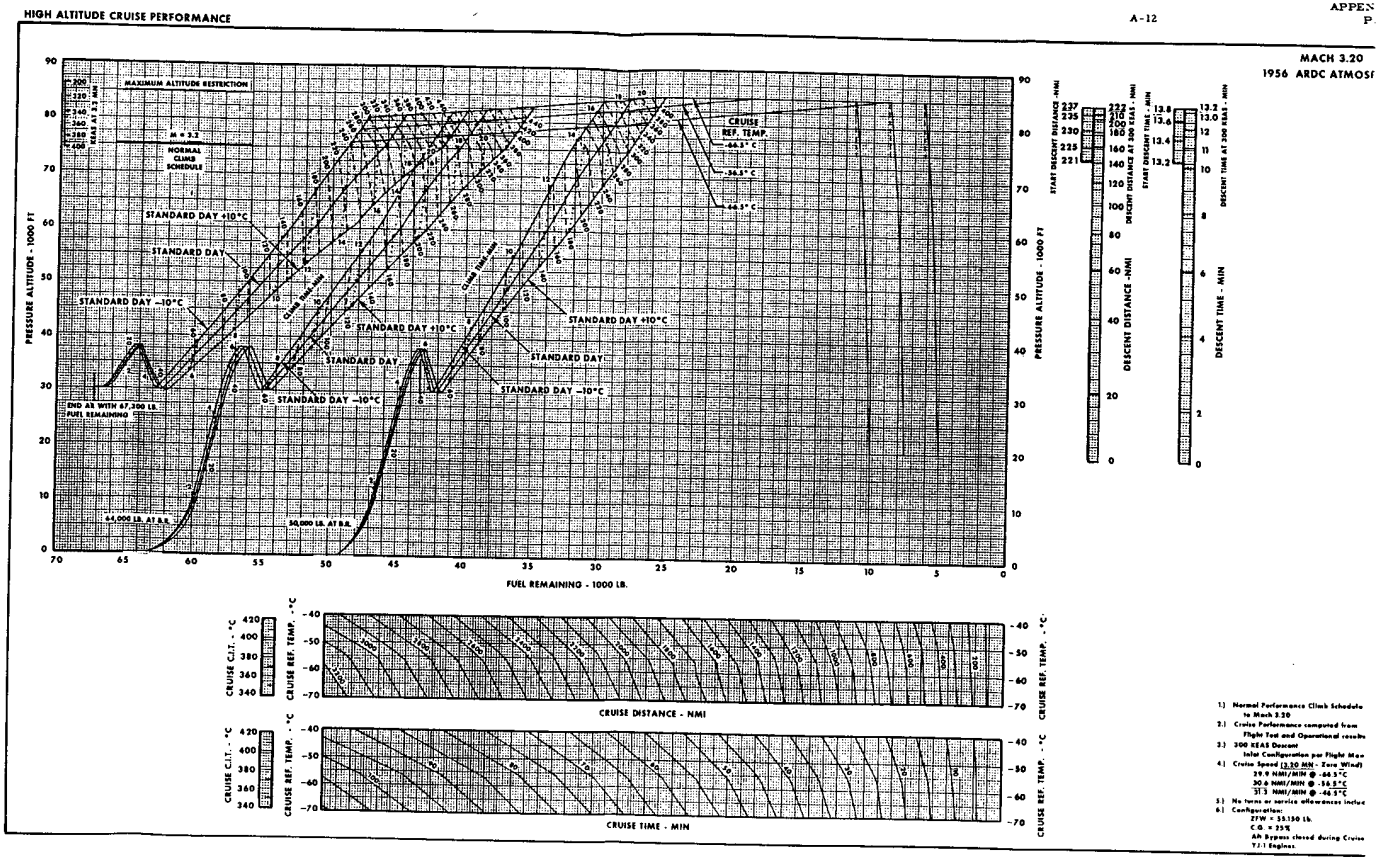


Figure 5-4

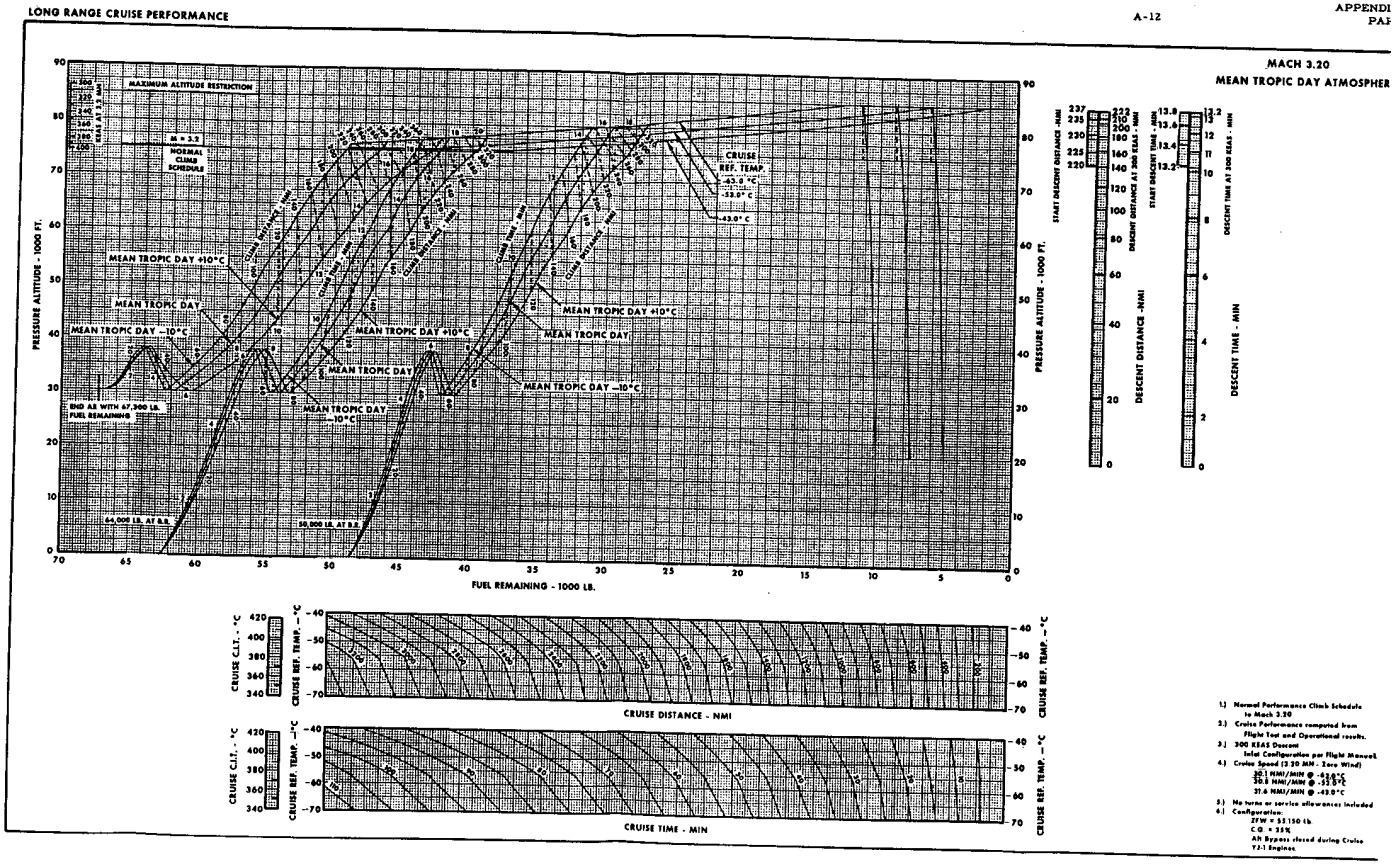
MACH 3.20
1956 ARDC ATMOSF


MAXIMUM ALTITUDE RESTRICTION
M = 3.2
NORMAL CLIMB SCHEDULE
STANDARD DAY +10°C
STANDARD DAY
STANDARD DAY −10°C
END AR WITH 67,300 LB. FUEL REMAINING
44,000 LB. AT S.R.
50,000 LB. AT S.R.
CRUISE REF. TEMP. −56.5°C
−66.5°C
−66.5°C
PRESSURE ALTITUDE - 1000 FT
FUEL REMAINING - 1000 LB.
START DESCENT DISTANCE -NMI
DESCENT DISTANCE AT 300 KEAS - NMI
DESCENT DISTANCE -NMI
START DESCENT TIME - MIN
DESCENT TIME AT 300 KEAS - MIN
DESCENT TIME - MIN
CRUISE C.I.T. - °C
CRUISE REF. TEMP. - °C
CRUISE DISTANCE - NMI
CRUISE TIME - MIN

1) Normal Performance Climb Schedule to Mach 3.20
2) Cruise Performance computed from Flight Test and Operational results
3) 300 KEAS Descent
Inlet Configuration per Flight Man
4) Cruise Speed (3.20 MN - Zero Wind)
39.9 NMI/MIN @ -66.5°C
30.6 NMI/MIN @ -56.5°C
31.3 NMI/MIN @ -66.5°C
5) No terms or service allowances include
6) Configuration:
ZFW = 35,150 Lb.
C.G. = 35%
Aft Bypass closed during Cruise
YJ-1 Engines

Changed 15 June 1968

Figure A5-7
(Sheet 3 of 3)



1.) Normal Performance Climb Schedule to Mach 3.20
2.) Cruise Performance computed from Flight Test and Operational results.
3.) 300 KEAS Descent
Initial Configuration per Flight Manual.
4.) Cruise Speed (3 20 MN - Zero Wind)
30.1 NMI/MIN @ -43.0 °C
30.8 NMI/MIN @ -53.5°C
31.6 NMI/MIN @ -43.0 °C
5.) No turns or service allowances included
6.) Configuration:
ZFW = 55 150 Lb
C.G. = 35%
All Bypass closed during Cruise
Y.J.1 Engines

Figure A5-9
(Sheet 3 of 3)

MINIMUM AIRSPEED LIMITS FOR 14° ANGLE OF ATTACK

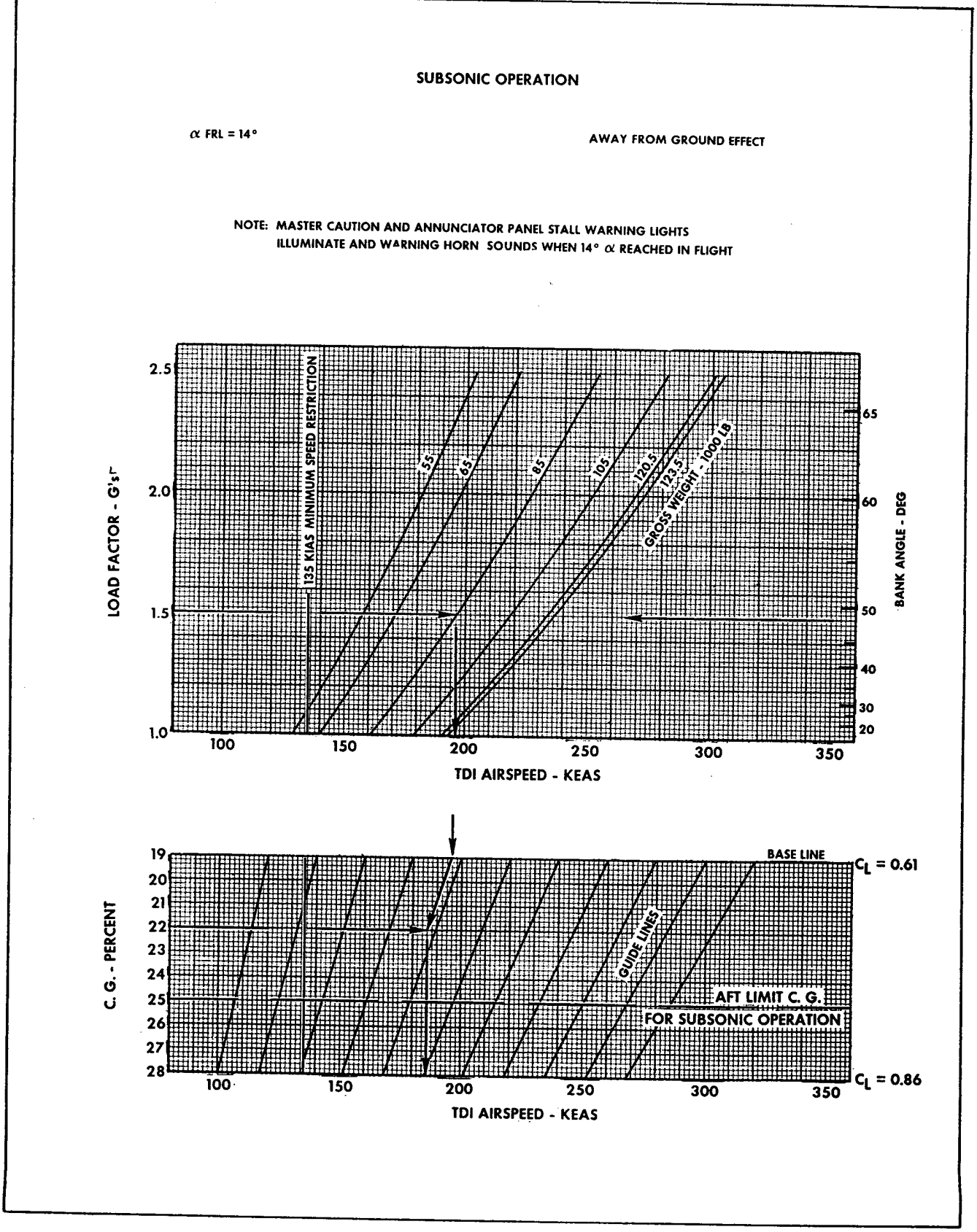


Figure 5-5

LIMIT LOAD FACTOR DIAGRAM

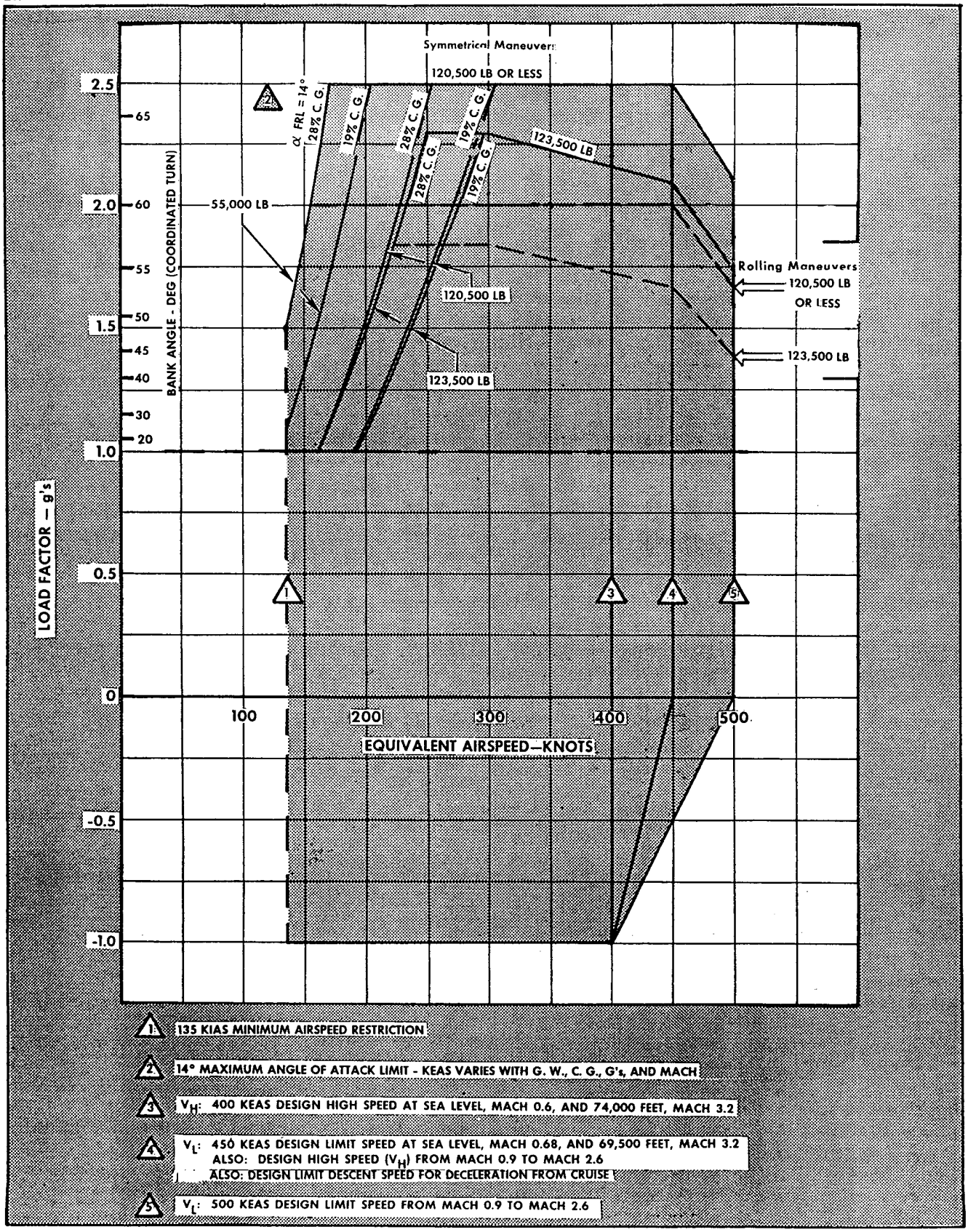


Figure 5-6

RATED TIRE SPEED

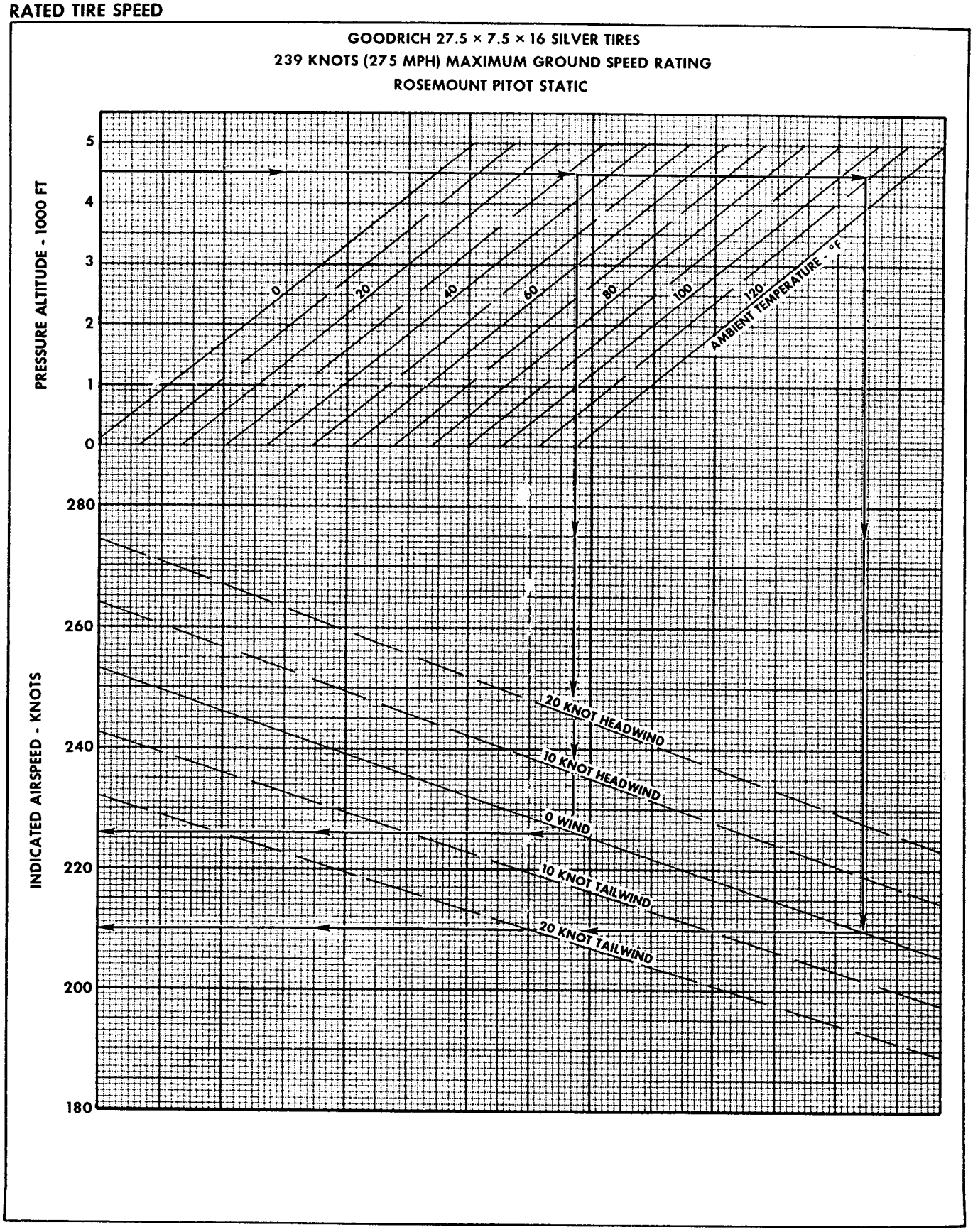


Figure 5-7

A red radial line at 135 KIAS represents the minimum subsonic speed restriction below 30,000 feet when the stall warning light is off.

EQUIVALENT AIRSPEED

The triple display indicator is not marked however, the limit equivalent speeds are as follows unless:

a. The Mach-airspeed instrument indicated airspeed equals either the limit airspeed hand indication or the minimum (135 KIAS) restriction.

b. The stall warning light illuminates or the stall warning tone is heard.

Maximum TDI Airspeed

The limit airspeed is 450 KEAS at sea level, increasing linearly with altitude to 500 KEAS at 9400 feet pressure altitude; then 500 KEAS between 9400 feet and the altitude for Mach 2.6. Limit airspeed then decreases linearly with Mach number to 450 KEAS at Mach 3.2. Normal operation cruise speed is 3.1 Mach.

Minimum TDI Airspeed

The minimum airspeed restriction varies linearly with Mach number from 135 KEAS (Mach 0.38) at 30,000 feet to 300 KEAS (Mach 1.34) at 50,000 feet, and is then a constant 300 KEAS to 85,000 feet (Mach 3.1).

LOAD FACTOR LIMITS

The maximum allowable positive load factor is 2.5 g's in symmetrical maneuvers and 2.0 g's in roll maneuvers as described by figure 5-6. The maximum negative load factor is -1.0 when below 400 KEAS varying from -1.0 to 0 g's at higher airspeed as shown by figure 5-6.

To avoid exceeding a safe angle of attack positive g's are limited to 1.5 g's when operating above 2.5 Mach. (This is equivalent to approximately a 45° bank level turn.)

PROHIBITED MANEUVERS

The aircraft shall be operated in a manner to avoid full stalls, spins, and inverted flight. Normal bank angle when operating above Mach 2.5 is 30 degrees.

RATE OF DESCENT LIMITATION

Rates of descent must be limited so as to maintain positive fuel tank pressure when sustained cruise speeds have exceeded Mach 2.8.

CENTER OF GRAVITY

The aircraft shall be operated within a c.g. range from 19% to 25% MAC while subsonic. The c.g. must be forward of 25% MAC for takeoff and should be as near to 19% MAC as possible with existing fuel for landing.

The aft c.g. limit is 28% MAC while supersonic. This limit results from stability considerations at high Mach number. Adequate stability exists at farther aft centers of gravity between Mach 1.2 and Mach 2.6 but for simplicity the aft limit is not changed. The purpose of elevon trim limits imposed in this Mach region is to alert the pilot of a major malfunction in the fuel system.

On those aircraft incorporating S/B 1141, if an aft c.g. emergency exists and EMER forward transfer is operated to place more than 4000 lbs in tank 1 and total fuel is less than 30,000 lbs, the aircraft should be limited to maneuvers causing not more than 1.5 g.

As elevon trim can be used as an indication of abnormal c.g. condition, the following pitch trim limits apply:

While subsonic - no more than 1° nose down.

LONG RANGE CRUISE PROFILE

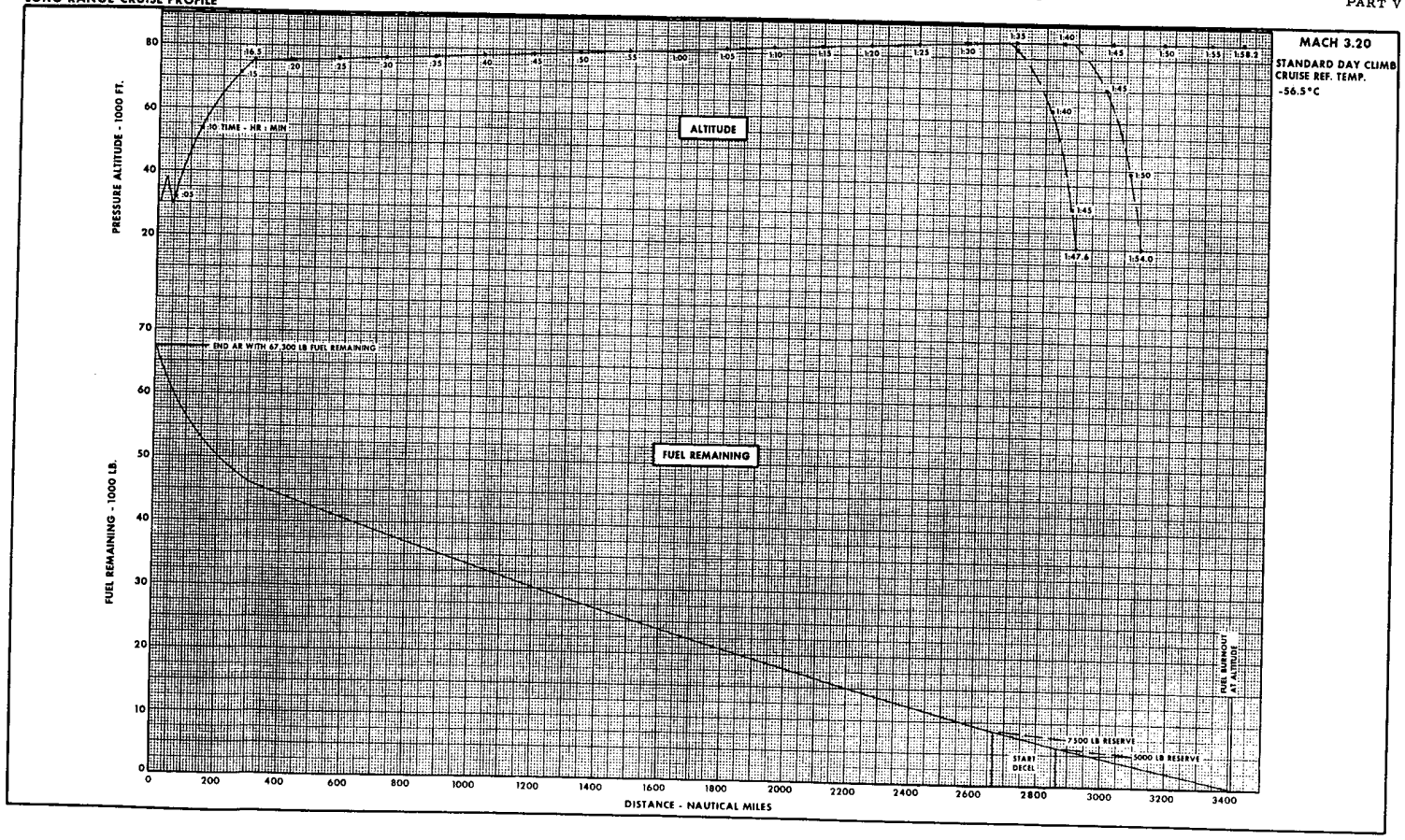


Figure A5-6

PROFILE CHART: CLIMB - CRUISE INTERCEPT POINTS

1956 ARDC ATMOSPHERE

LONG RANGE CRUISE - MACH 3.20

INITIAL GR. WT. LB.	INITIAL ALTITUDE FT.	CLIMB TEMP °C	CRUISE TEMP. °C	CLIMB - CRUISE INTERCEPT			
				ALTITUDE FT.	DISTANCE N. Mi.	TIME MIN.	FUEL REM. LB.
122,450	30,000	STD -10	-66.5	77,050	258	14.6	48,410
			-56.5	75,296	237	13.9	48,875
			-46.5	75,296	237	13.9	48,875
		STD	-66.5	77,500	326	17.4	45,620
			-56.5	75,500	302	16.6	46,150
			-46.5	75,296	299	16.5	46,205
		STD +10	-66.5	78,350	438	22.0	41,070
			-56.5	76,450	416	21.3	41,570
			-46.5	75,296	402	20.8	41,875
119,150	S.L.	STD -10	-66.5	78,200	267	16.9	42,130
			-56.5	76,200	244	16.1	42,665
			-46.5	75,296	233	15.8	42,905
		STD	-66.5	78,600	326	19.5	39,650
			-56.5	76,750	305	18.8	40,145
			-46.5	75,296	287	18.2	40,530
		STD +10	-66.5	79,350	421	23.6	36,075
			-56.5	77,400	398	22.8	36,595
			-46.5	75,800	379	22.1	37,020
105,150	S.L.	STD -10	-66.5	80,400	254	15.3	30,980
			-56.5	78,550	233	14.5	31,475
			-46.5	76,900	213	13.9	31,915
		STD	-66.5	80,800	301	17.3	28,915
			-56.5	79,050	281	16.6	29,380
			-46.5	76,400	249	15.5	30,085
		STD +10	-66.5	81,450	375	20.4	26,280
			-56.5	79,750	355	19.7	26,735
			-46.5	78,000	335	19.0	27,200

Figure A5-6
(Sheet 2 of 3)

While climbing - 2-1/2° nose down from Mach 1.4 to Mach 2.6, 3-1/2° nose down above Mach 2.6.

At initial cruise the trim limit is 3-1/2° nose down at 28% c.g. As altitude increases and KEAS decreases, the 28% c.g. trim limit becomes approximately 2° more nose up per 50 KEAS decrease from 450 KEAS. (In addition, expect approximately 1° more nose up trim for each percent that c.g. is forward of 28% MAC).

FUEL LOADING LIMITATIONS

These limits to be supplied at the operating site.

AIRCRAFT SYSTEM LIMITATIONS

STABILITY AUGMENTATION SYSTEM

The SAS shall be on for all takeoffs and landings.

INLET SPIKE AND BYPASS CONTROLS

The spike and forward bypass controls must be operated in the AUTO mode at all times when above 80,000 feet. When inlet controls must be operated manually, maximum allowable speed is Mach 3.0.

CANOPY

The canopy shall be opened or closed only when the aircraft is completely stopped. Maximum taxi speed with the canopy open is 40 knots. Gusts or strong winds should be considered as a portion of the 40 knot speed limit.

LANDING GEAR SYSTEM

Landing Gear

Do not exceed 300 KEAS or Mach 0.9 with a maximum of 5° sideslip with gear extended. When sideslip angle exceeds 5°, operation with gear extended is limited to Mach 0.7 or 300 KEAS. Operation at supersonic speed with gear extended is prohibited. The landing gear is designed for landing sink speeds at touchdown which decrease from 9 FPS at 57,000 pounds to 5 FPS at 123,600 pounds. Side loads during takeoff, landing, and taxiing must be kept to a minimum, as landing gear side load strength is critical during ground maneuvering.

Tires

The maximum taxi speed recommended is 40 knots for Goodrich 27.5 x 7.5 x 16 "silver" tires. The rated ground speed limit is 239 knots. At 4500 feet elevation, 239 knots corresponds to 210 KIAS with 108°F ambient temperature on a calm day, and 226 KIAS at 32°F ambient temperature. Limit indicated airspeed on the ground decreases by the amount of tailwind component along the runway and increases by the headwind component. Refer to figure 5-7 for rated speeds at other altitudes and temperatures.

Taxiing Restrictions

A heat check is required for tires, wheels, and brakes:

a. Prior to takeoff when taxiing has exceeded one statute mile.

b. When continuous taxi distance has exceeded 5 statute miles.

c. When clear of the runway after an aborted takeoff or a heavy weight landing.

INITIAL BRAKING SPEED FOR STOP USING RATED BRAKE CAPACITY

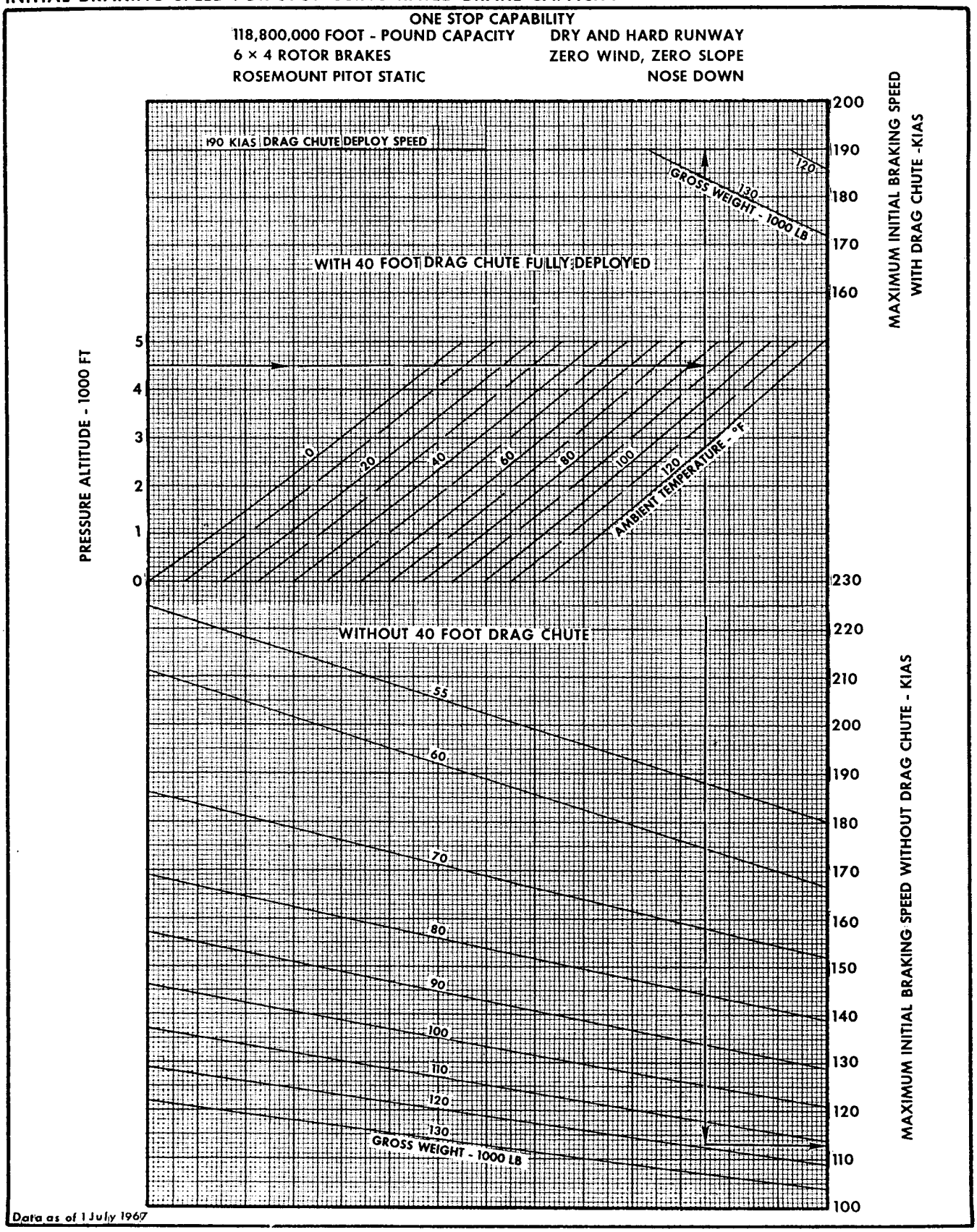
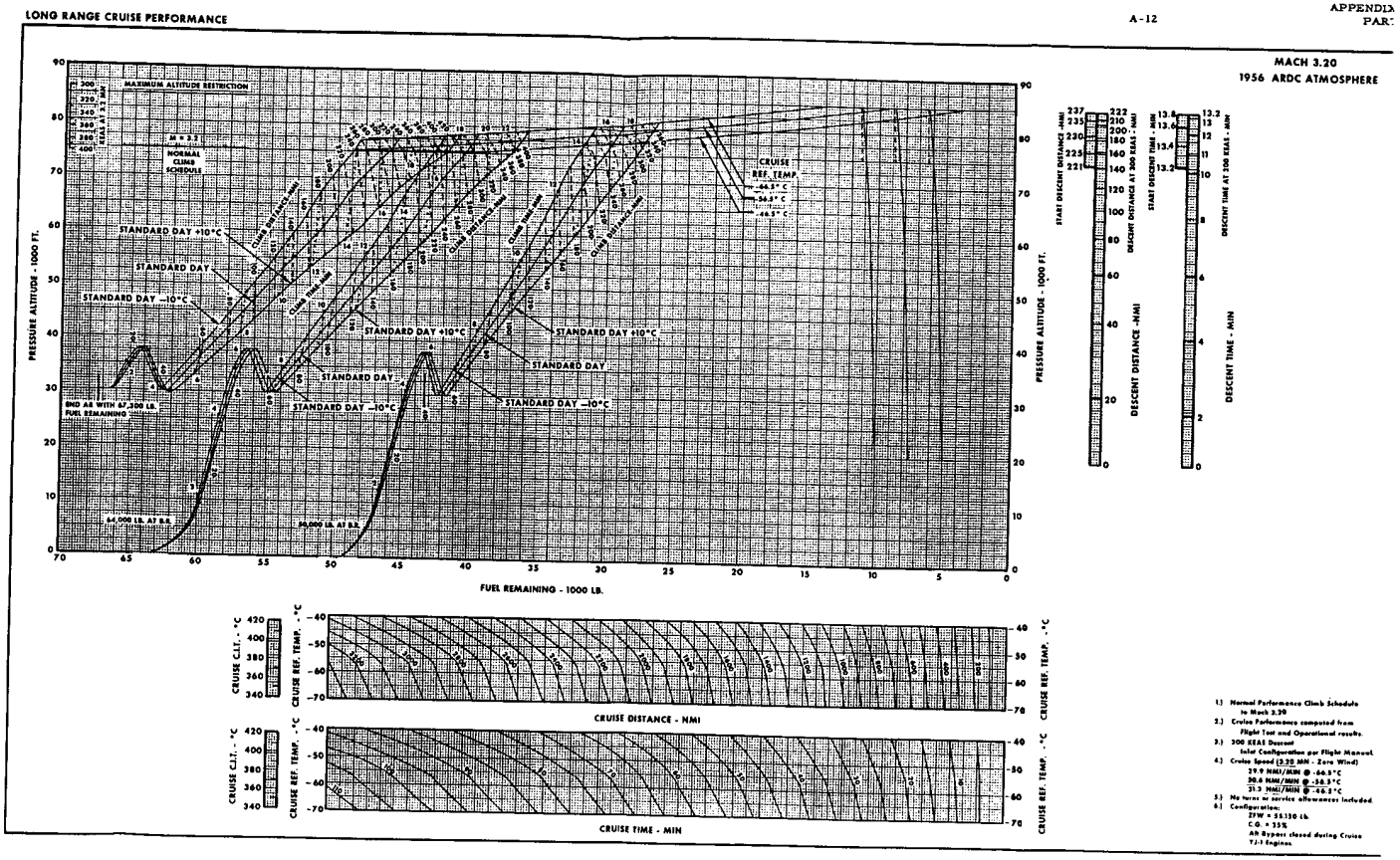


Figure 5-8



1.) Normal Performance Climb Schedule to Mach 3.20
2.) Cruise Performance computed from Flight Test and Operational results.
3.) 300 KEAS Descent
Inlet Configuration per Flight Manual.
4.) Cruise Speed (3.20 MN - Zero Wind)
29.9 NMI/MIN @ -66.5°C
30.6 NMI/MIN @ -56.5°C
31.3 NMI/MIN @ -46.5°C
5.) No turns or service allowances included.
6.) Configuration:
ZFW = 259,250 Lb.
C.G. = 35%
Aft Bypass closed during Cruise
TJ-1 Engines

Changed 15 June 1968

Figure A5-6
(Sheet 3 of 3)

If required, cooling should be accomplished until ground inspection reveals that the tires and wheels are sufficiently cooled for continued operations (temperatures relatively tolerable to the touch).

NOTE

Cooling may be accelerated by use of fans.

Abort during takeoff roll requires a tire change.

Brakes

The one-stop energy rating of the brakes is 118,800,000 foot-pounds. Speeds corresponding to these energy ratings from which stops can be made vary with gross weight, ambient temperature, altitude, wind, and whether or not the drag chute is deployed. Corresponding indicated airspeed, altitude, temperature, and weight conditions are shown by figure 5-8 for the above rating for stops on dry runways with zero wind component. Headwind components may be added to values shown, and tailwind components must be subtracted from values illustrated. There is no limiation on airspeed for brake application at normal landing weights when the drag chute is used. Refer to Part II of the appendix for detailed information related to maximum refusal speeds and heavyweight landings with various operating conditions.

Brakes in a new condition have a capacity for one hard stop from rated speed. If applied sooner, they will burn out prior to stop. In normal operations, delaying brake application until below 75% of limit speeds reduces wear and conserves brake capacity for high energy stops.

If brakes chatter at slow speeds during taxi, turns, and at the end of the landing roll, light braking only must be used to avoid "walking the gear" and cyclic loads on the airframe structure.

DRAG CHUTE LIMITATIONS

The maximum speed for drag chute deployment is 210 KIAS.

LN_2 Quantity Indicator

The LN_2 quantity indicator is marked with a yellow caution arc between 0 and 30 liters remaining. Approximately 60 liters of liquid nitrogen are required for a normal descent from cruise altitude to landing. Descents initiated with less than 30 liters per system or 60 liters total may deplete the LN_2 system and require use of emergency procedures for fuel tank pressurization failure as lower altitudes are reached.

AUTOPILOT SYSTEM

Updated autopilots now have no limitations when operating within the normal flight operating envelope.

WARNING

An autopilot hardover failure at speeds in excess of 450 KEAS below 10,000 feet or speeds in excess of 465 KEAS between 20,000 and 30,000 feet will cause excessive load factor if immediate pilot corrective action is not accomplished.

OXYGEN SYSTEM

Flights without a pressure suit, using the oxygen mask and regulator, are restricted to altitudes below FL 500 and speeds below 420 KEAS.

PROFILE CHART: CLIMB - CRUISE INTERCEPT POINTS

1956 ARDC ATMOSPHERE

HIGH ALTITUDE CRUISE - MACH 3.20

INITIAL GR. WT. LB.	INITIAL ALTITUDE FT.	CLIMB TEMP. °C	CRUISE TEMP. °C	CLIMB - CRUISE INTERCEPT			
				ALTITUDE FT.	DISTANCE N. MI.	TIME MIN.	FUEL REM LB.
122,450	30,000	STD -10	-66.5	80,600	301	16.0	47,465
			-56.5	78,400	275	15.1	48,050
			-46.5	76,000	246	14.2	48,690
		STD	-66.5	81,150	369	18.8	44,645
			-56.5	78,900	343	17.9	45,245
			-46.5	76,450	314	17.0	45,900
		STD +10	-66.5	82,000	482	23.5	40,090
			-56.5	79,800	457	22.6	40,675
			-46.5	77,350	428	21.6	41,330
119,150	S.L.	STD -10	-66.5	81,800	310	18.4	41,175
			-56.5	79,600	285	17.5	41,760
			-46.5	77,150	256	16.5	42,410
		STD	-66.5	82,200	369	21.0	38,690
			-56.5	80,100	345	20.1	39,250
			-46.5	77,600	316	19.1	39,915
		STD +10	-66.5	83,050	465	25.0	35,090
			-56.5	80,800	439	24.1	35,690
			-46.5	78,400	411	23.2	36,330
105,150	S.L.	STD -10	-66.5	84,200	300	16.8	29,975
			-56.5	82,000	275	15.9	30,555
			-46.5	79,400	245	14.9	31,250
		STD	-66.5	84,700	348	18.9	27,875
			-56.5	82,450	323	18.0	28,475
			-46.5	79,850	292	16.9	29,080
		STD +10	-66.5	85,000	417	21.8	25,335
			-56.5	84,150	409	21.5	25,560
			-46.5	80,450	365	20.0	26,550

Figure A5-7
(Sheet 2 of 3)

HIGH ALTITUDE CRUISE PROFILE

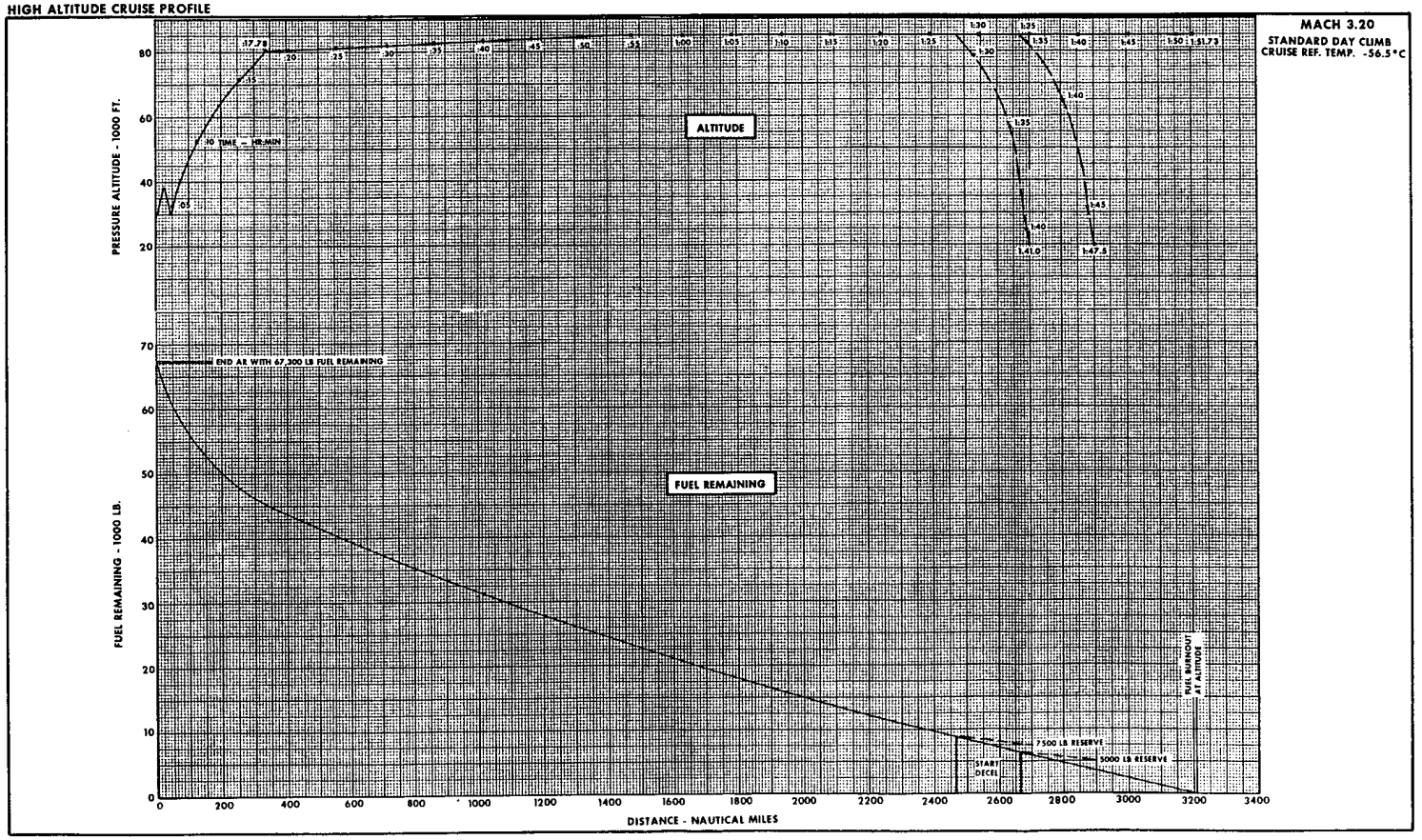


Figure A5-7

(Sheet 1 of 2)

HIGH ALTITUDE CRUISE PROFILE

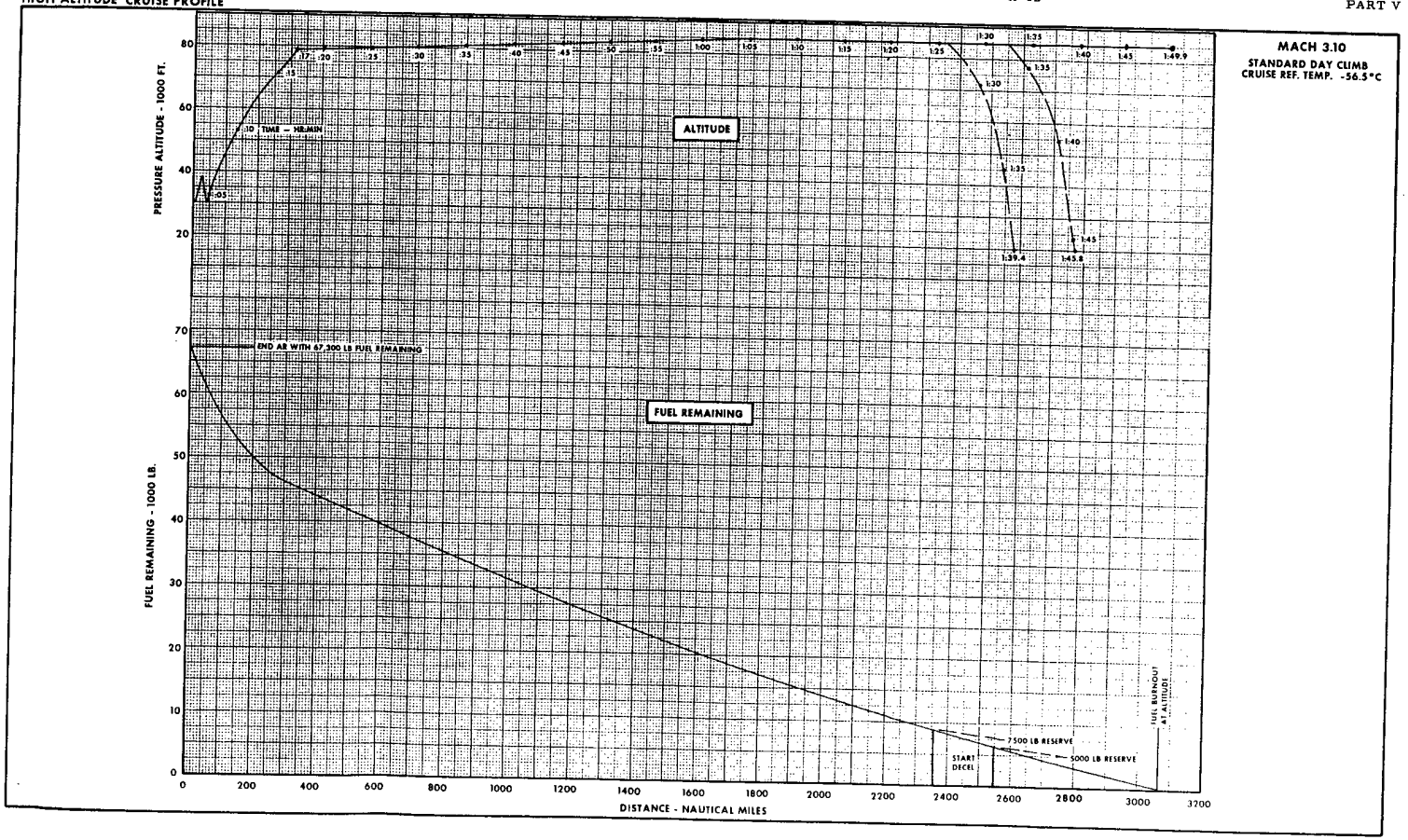


Figure A5-17

(Sheet 1 of 3)

PROFILE CHART: CLIMB - CRUISE INTERCEPT POINTS

1956 ARDC ATMOSPHERE

HIGH ALTITUDE CRUISE - MACH 3.10

INITIAL GR. WT. LB.	INITIAL ALTITUDE FT.	CLIMB TEMP. °C	CRUISE TEMP. °C	CLIMB - CRUISE INTERCEPT			
				ALTITUDE FT.	DISTANCE N. MI.	TIME MIN.	FUEL REM LB.
122,450	30,000	STD -10	-66.5	79,000	290	15.7	47,955
			-56.5	76,750	265	14.8	48,555
			-46.5	74,400	237	13.9	49,180
		STD	-66.5	79,550	349	18.3	45,335
			-56.5	77,200	323	17.3	45,965
			-46.5	74,800	295	16.4	46,605
		STD +10	-66.5	80,400	449	22.5	41,185
			-56.5	77,950	422	21.5	41,835
			-46.5	75,600	395	20.6	42,360
119,150	S.L.	STD -10	-66.5	80,250	303	18.2	41,655
			-56.5	77,800	276	17.2	42,305
			-46.5	75,250	246	16.2	42,985
		STD	-66.5	80,750	355	20.6	39,300
			-56.5	78,250	328	19.6	39,960
			-46.5	76,000	302	18.7	40,560
		STD +10	-66.5	81,400	371	24.2	35,945
			-56.5	78,900	344	23.1	36,615
			-46.5	76,600	318	22.3	37,225
105,150	S.L.	STD -10	-66.5	82,650	292	16.7	30,245
			-56.5	80,050	264	15.6	30,940
			-46.5	77,800	238	14.7	31,540
		STD	-66.5	83,100	335	18.6	28,370
			-56.5	80,500	307	17.5	29,060
			-46.5	78,200	281	16.6	29,670
		STD +10	-66.5	83,750	402	21.5	25,735
			-56.5	81,150	374	20.5	26,425
			-46.5	78,800	348	19.6	27,050

Figure A5-17
(Sheet 2 of 3)

PROFILE CHART: CLIMB - CRUISE INTERCEPT POINTS

MEAN TROPIC ATMOSPHERE

LONG RANGE CRUISE - MACH 3.20

INITIAL GR. WT. LB.	INITIAL ALTITUDE FT.	CLIMB TEMP. °C	CRUISE TEMP. °C	CLIMB - CRUISE INTERCEPT			
				ALTITUDE FT.	DISTANCE N. MI.	TIME MIN.	FUEL REM. LB.
122,450	30,000	M.T. -10	-63.0	76,050	230	13.6	49,025
			-53.0	75,296	221	13.3	49,225
			-43.0	75,296	221	13.3	49,225
		M.T.	-63.0	76,600	290	16.2	46,395
			-53.0	75,296	274	15.7	46,740
			-43.0	75,296	274	15.7	46,740
		M.T. +10	-63.0	77,400	382	20.2	42,290
			-53.0	75,450	359	19.5	42,810
			-43.0	75,296	357	19.4	42,850
119,150	S.L.	M.T. -10	-63.0	77,200	229	15.6	43,645
			-53.0	75,296	206	14.9	44,150
			-43.0	75,296	206	14.9	44,150
		M.T.	-63.0	77,550	274	17.8	41,760
			-53.0	75,600	250	17.0	42,280
			-43.0	75,296	247	16.9	42,360
		M.T. +10	-63.0	78,150	340	20.7	38,860
			-53.0	76,150	316	19.9	39,395
			-43.0	75,296	306	19.5	39,620
105,150	S.L.	M.T. -10	-63.0	79,750	236	14.9	31,285
			-53.0	77,750	223	14.1	31,815
			-43.0	76,350	196	13.5	32,190
		M.T.	-63.0	80,150	277	16.7	29,660
			-53.0	78,150	254	15.9	30,190
			-43.0	76,750	237	15.4	30,565
		M.T. +10	-63.0	80,750	336	19.2	27,100
			-53.0	78,700	312	18.4	27,645
			-43.0	77,300	296	17.9	28,015

Figure A5-9
(Sheet 2 of 3)

LONG RANGE CRUISE PROFILE

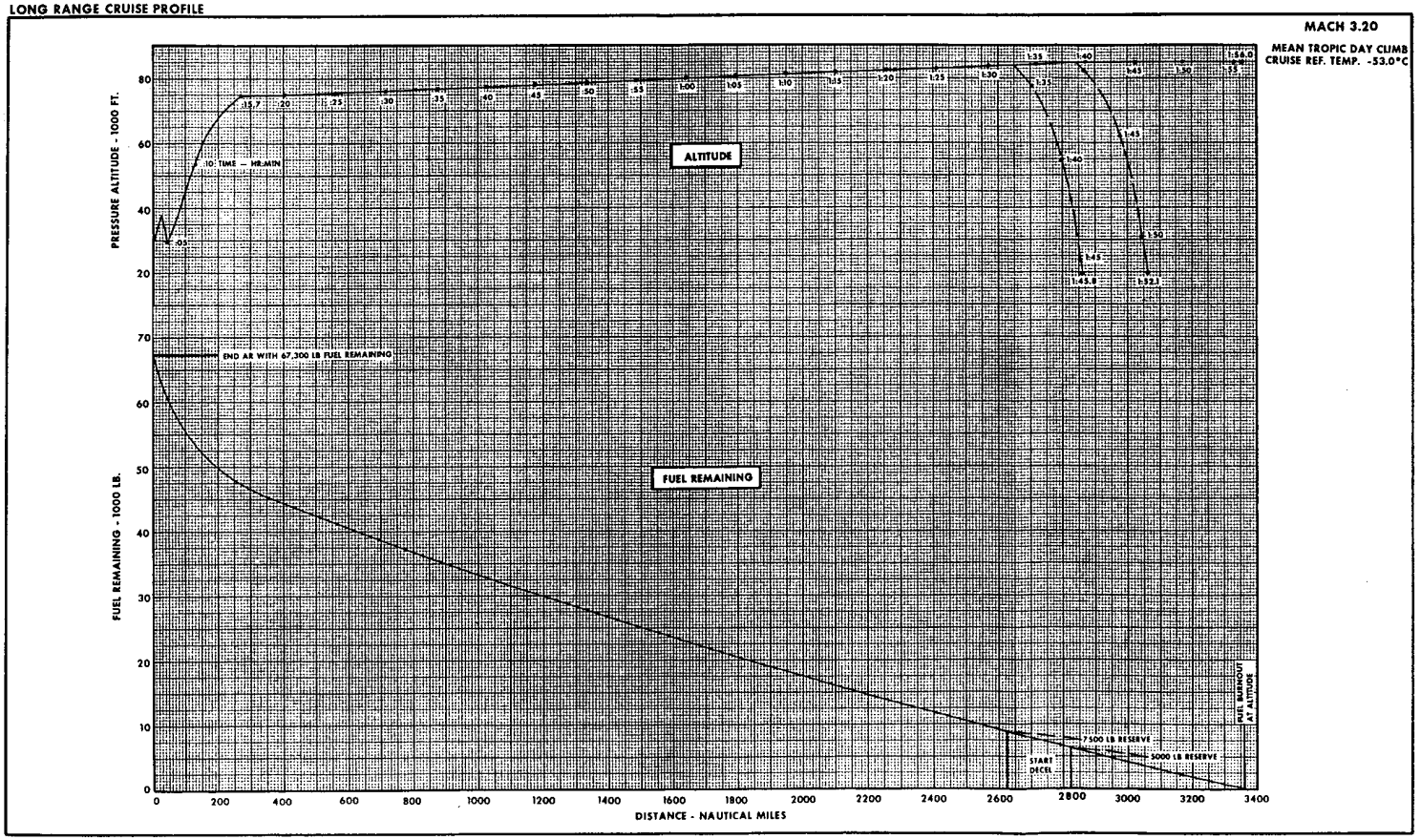


Figure A5-9 (Sheet 1 of 3)

PROFILE CHART: CLIMB - CRUISE INTERCEPT POINTS

MEAN TROPIC ATMOSPHERE

HIGH ALTITUDE CRUISE - MACH 3.20

INITIAL GR. WT. LB.	INITIAL ALTITUDE FT.	CLIMB TEMP. °C	CRUISE TEMP. °C	CLIMB - CRUISE INTERCEPT			
				ALTITUDE FT	DISTANCE N. MI.	TIME MIN.	FUEL REM. LB.
122,450	30,000	M.T. -10	-63.0	79,800	276	15.1	48,025
			-53.0	77,500	249	14.2	48,640
			-43.0	75,296	221	13.3	49,225
		M.T.	-63.0	80,250	334	17.7	45,420
			-53.0	78,000	307	16.8	46,020
			-43.0	75,500	277	15.8	46,685
		M.T. +10	-63.0	81,000	426	21.7	41,330
			-53.0	78,750	400	20.8	41,930
			-43.0	76,300	370	19.8	42,585
119,150	S.L.	M.T. -10	-63.0	80,800	272	17.1	42,685
			-53.0	78,500	246	16.2	43,295
			-43.0	76,000	215	15.2	43,965
		M.T.	-63.0	81,150	317	19.2	40,800
			-53.0	78,850	290	18.3	41,425
			-43.0	76,400	260	17.3	42,065
		M.T. +10	-63.0	81,650	381	22.0	37,955
			-53.0	79,400	356	21.2	38,530
			-43.0	77,000	327	20.2	39,165
105,150	S.L.	M.T. -10	-63.0	83,400	280	16.4	30,310
			-53.0	81,000	253	15.4	30,950
			-43.0	78,500	223	14.4	31,615
		M.T.	-63.0	83,800	321	18.2	28,690
			-53.0	81,400	294	17.2	29,325
			-43.0	78,850	264	16.2	30,005
		M. T. +10	-63.0	84,450	378	20.7	26,140
			-53.0	82,000	353	19.7	26,765
			-43.0	79,400	322	18.7	27,460

Figure A5-10
(Sheet 2 of 3)

HIGH ALTITUDE CRUISE PROFILE

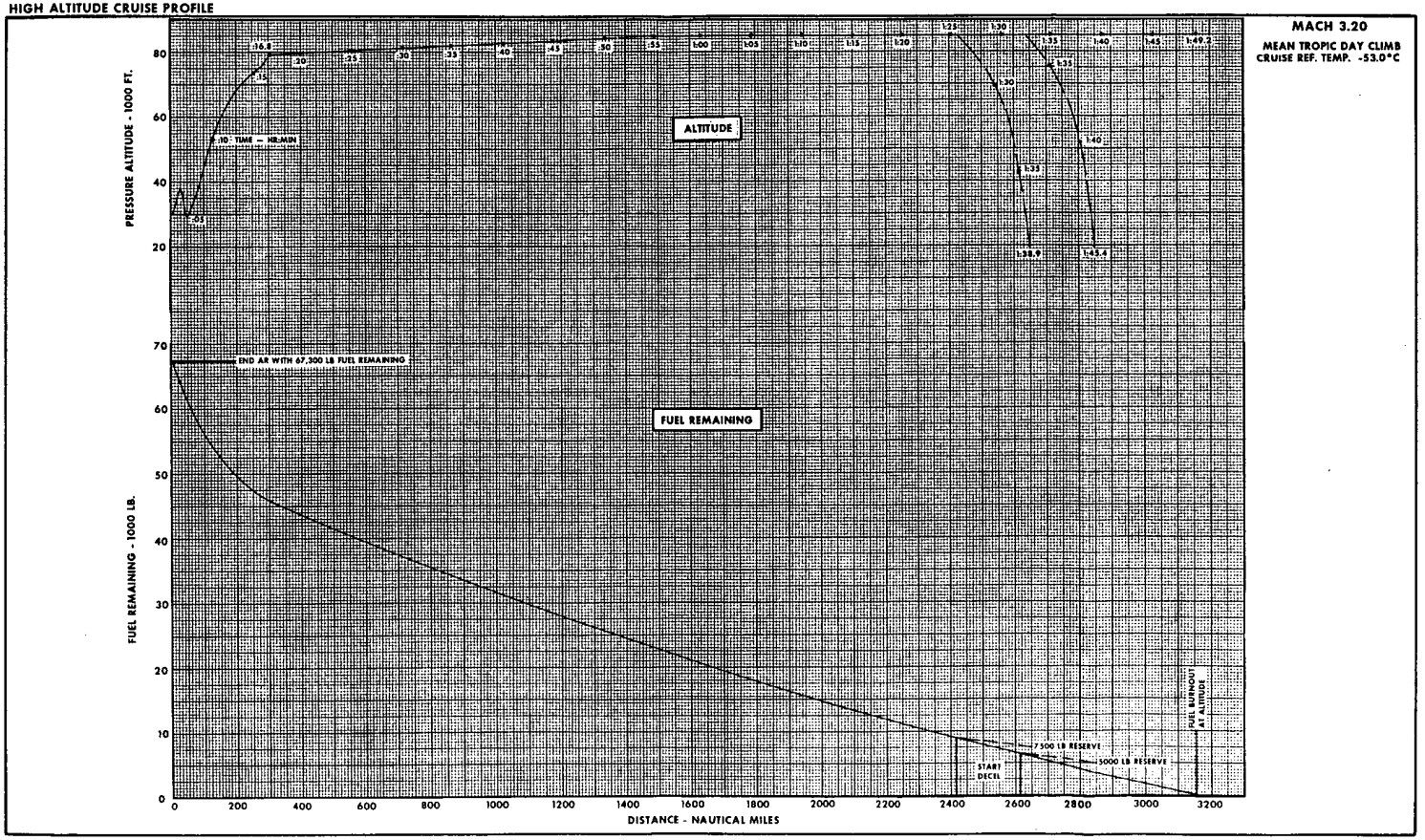

MACH 3.20
MEAN TROPIC DAY CLIMB
CRUISE REF. TEMP. -53.0°C
ALTITUDE
FUEL REMAINING
END AR WITH 67,300 LB FUEL REMAINING
PRESSURE ALTITUDE - 1000 FT.
FUEL REMAINING - 1000 LB.
DISTANCE - NAUTICAL MILES
7500 LB RESERVE
5000 LB RESERVE
START DECEL
FUEL EXHAUST
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000 3200
0 10 20 30 40 50 60 70 80

Figure A5-10

(Sheet 1 of 3)

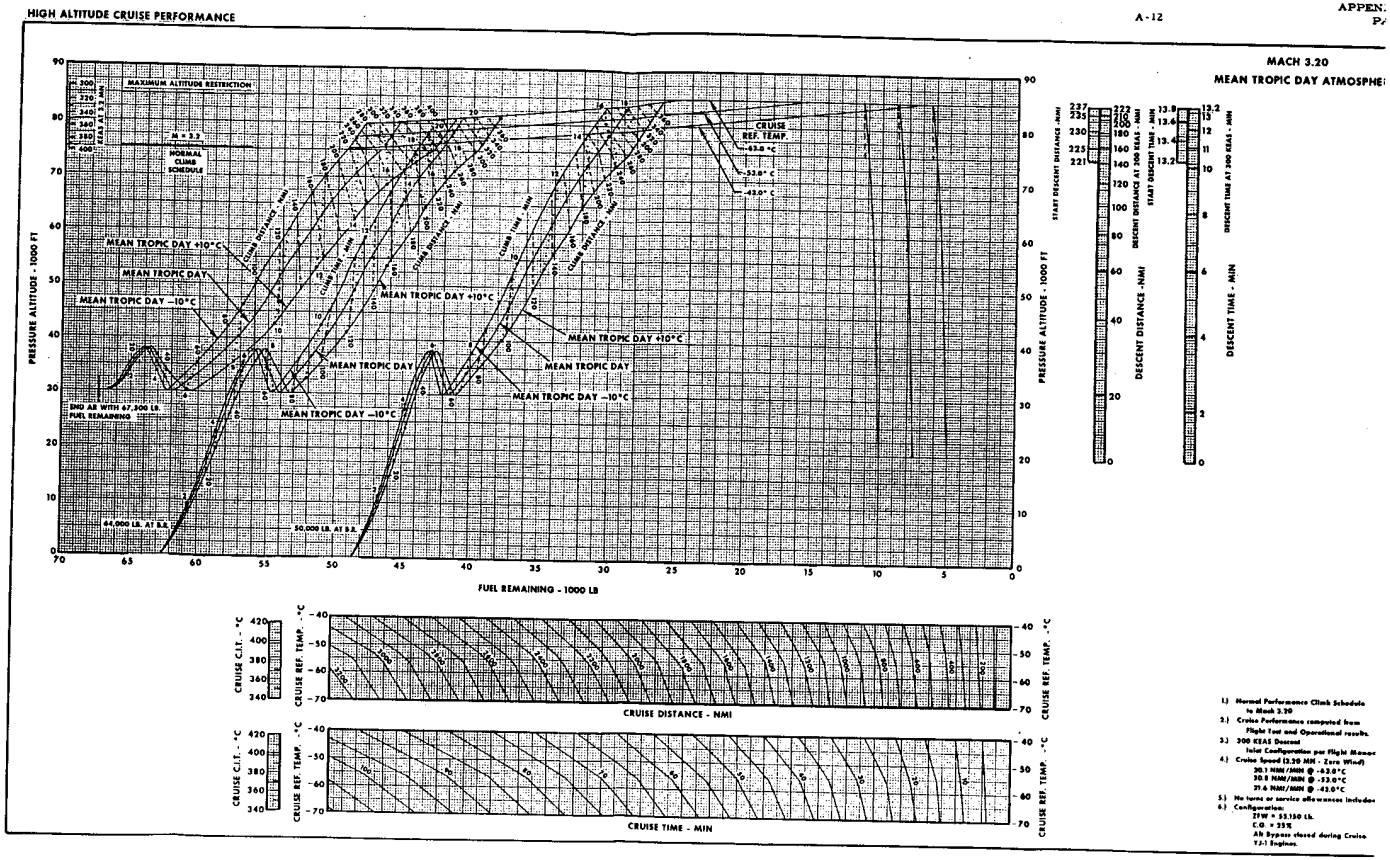

MACH 3.20
MEAN TROPIC DAY ATMOSPHE
MAXIMUM ALTITUDE RESTRICTION
NORMAL CLIMB SCHEDULE
M = 3.2
MEAN TROPIC DAY +10°C
MEAN TROPIC DAY
MEAN TROPIC DAY –10°C
CRUISE REF. TEMP.
-53.0 °C
-43.0 °C
END AR WITH 67,300 LB. FUEL REMAINING
64,000 LB. AT S.A.
50,000 LB. AT S.A.
PRESSURE ALTITUDE - 1000 FT
FUEL REMAINING - 1000 LB
START DESCENT DISTANCE - NMI
DESCENT DISTANCE - NMI
START DESCENT TIME - MIN
DESCENT TIME - MIN
DESCENT TIME AT 300 KEAS - MIN
CRUISE C.I.T. - °C
CRUISE REF. TEMP. - °C
CRUISE DISTANCE - NMI
CRUISE TIME - MIN
1) Normal Performance Climb Schedule to Mach 3.20
2) Cruise Performance computed from Flight Test and Operational results.
3) 300 KEAS Descent Inlet Configuration per Flight Manual
4) Cruise Speed (3.20 MN - Zero Wind)
30.1 NMI/MIN @ -43.0°C
30.5 NMI/MIN @ -53.0°C
31.6 NMI/MIN @ -63.0°C
5) No turns or service allowances included
6) Configuration:
ZFW = 55,150 Lb.
C.G. = 33%
All Bypass closed during Cruise.
YJ-1 Engines.

Figure A5-10
(Sheet 3 of 3)

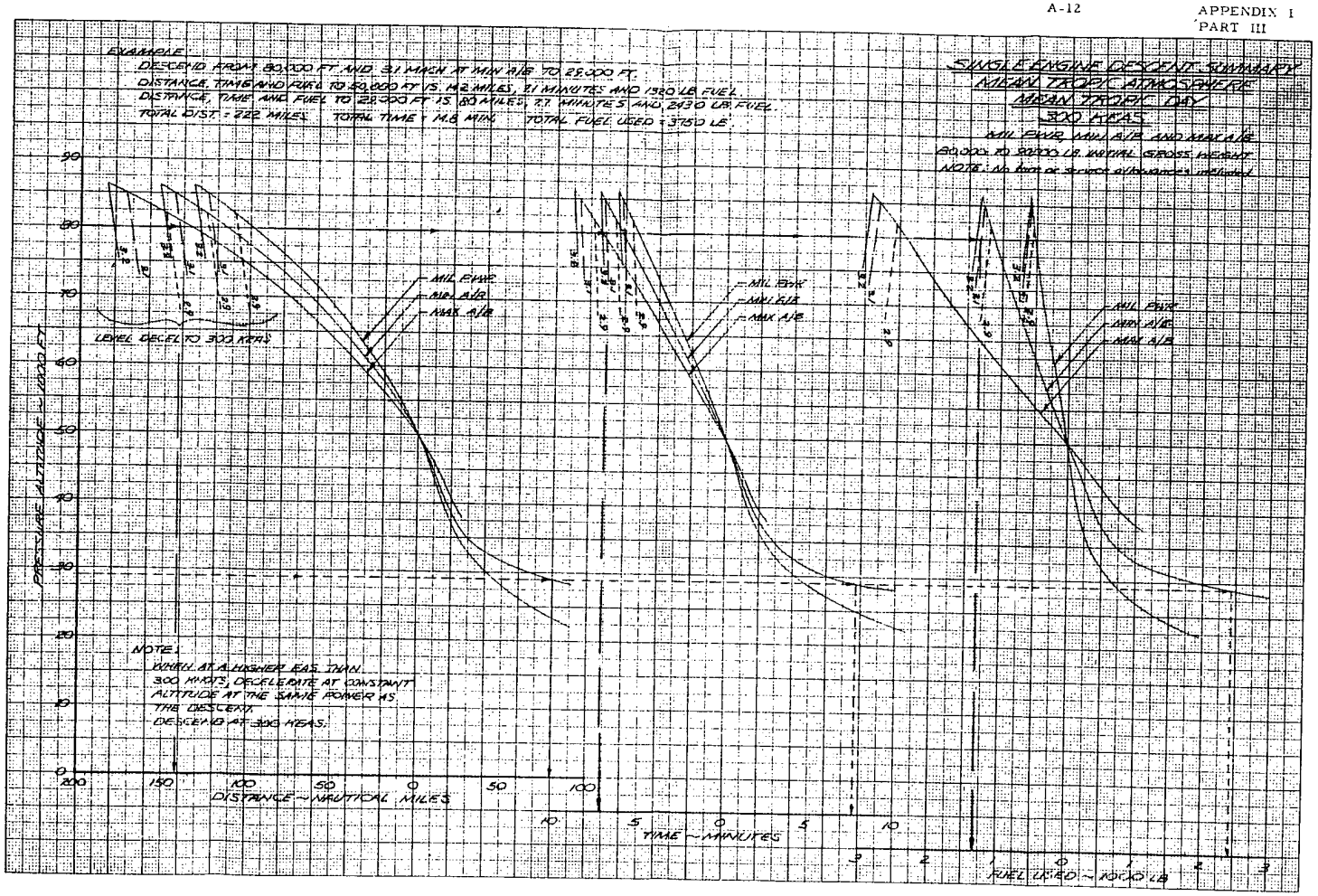

EXAMPLE
DESCEND FROM 30,000 FT. AND .81 MACH AT MIN A/B TO 25,000 FT.
DISTANCE, TIME AND FUEL TO 30,000 FT. IS 42 MILES, 21 MINUTES AND 1320 LB. FUEL.
DISTANCE, TIME AND FUEL TO 25,000 FT. IS 80 MILES, 2.7 MINUTES AND 2430 LB. FUEL.
TOTAL DIST. = 722 MILES TOTAL TIME = 4.8 MIN. TOTAL FUEL USED = 3750 LB.
SINGLE ENGINE DESCENT SUMMARY
MEAN TROPIC ATMOSPHERE
MEAN TROPIC DAY
300 KEAS
MIL PWR, MIN A/B AND MAX A/B
30,000 TO 20,000 LB. INITIAL GROSS WEIGHT
NOTE: NO BOOK OR SERVICE ALLOWANCE INCLUDED
MIL PWR
MIN A/B
MAX A/B
LEVEL DECEL TO 300 KEAS
NOTE:
WHEN AT A HIGHER EAS THAN 300 KNOTS, DECELERATE AT CONSTANT ALTITUDE AT THE SAME POWER AS THE DESCENT.
DESCEND AT 300 KEAS.
ALTITUDE — THOUSANDS OF FEET ABOVE SEA LEVEL
DISTANCE — NAUTICAL MILES
TIME — MINUTES
FUEL USED — POUNDS

Figure A3-23

PROFILE CHART: CLIMB - CRUISE INTERCEPT POINTS

1956 ARDC ATMOSPHERE

LONG RANGE CRUISE - MACH 3.10

INITIAL GR. WT. LB.	INITIAL ALTITUDE FT.	CLIMB TEMP. °C	CRUISE TEMP. °C	CLIMB - CRUISE INTERCEPT			
				ALTITUDE FT.	DISTANCE N. MI.	TIME MIN.	FUEL REM. LB.
122,450	30,000	STD -10	-66.5	74,600	239	14.0	49,130
			-56.5	73,200	223	13.4	49,500
			-46.5	72,920	219	13.3	49,575
		STD	-66.5	75,050	296	16.4	46,565
			-56.5	73,700	281	15.9	46,900
			-46.5	72,920	272	15.6	47,105
		STD +10	-66.5	75,850	396	20.7	42,395
			-56.5	74,450	380	20.1	42,770
			-46.5	73,400	368	19.7	43,050
119,150	S.L.	STD -10	-66.5	75,800	251	16.4	42,840
			-56.5	74,400	235	15.8	43,210
			-46.5	73,300	222	15.4	43,505
		STD	-66.5	76,200	303	18.7	40,505
			-56.5	74,800	287	18.2	40,880
			-46.5	73,750	275	17.8	41,160
		STD +10	-66.5	76,850	319	22.4	37,160
			-56.5	75,450	303	21.9	37,530
			-46.5	74,350	291	21.4	37,825
105,150	S.L.	STD -10	-66.5	78,050	239	14.8	31,470
			-56.5	76,600	223	14.2	31,860
			-46.5	75,450	210	13.8	32,165
		STD	-66.5	78,450	281	16.7	29,610
			-56.5	77,000	266	16.1	29,990
			-46.5	75,850	253	15.7	30,300
		STD +10	-66.5	79,050	347	19.7	26,990
			-56.5	77,600	332	19.1	27,375
			-46.5	76,400	318	18.6	27,695

Figure A5-16
(Sheet 2 of 3)

LONG RANGE CRUISE PROFILE

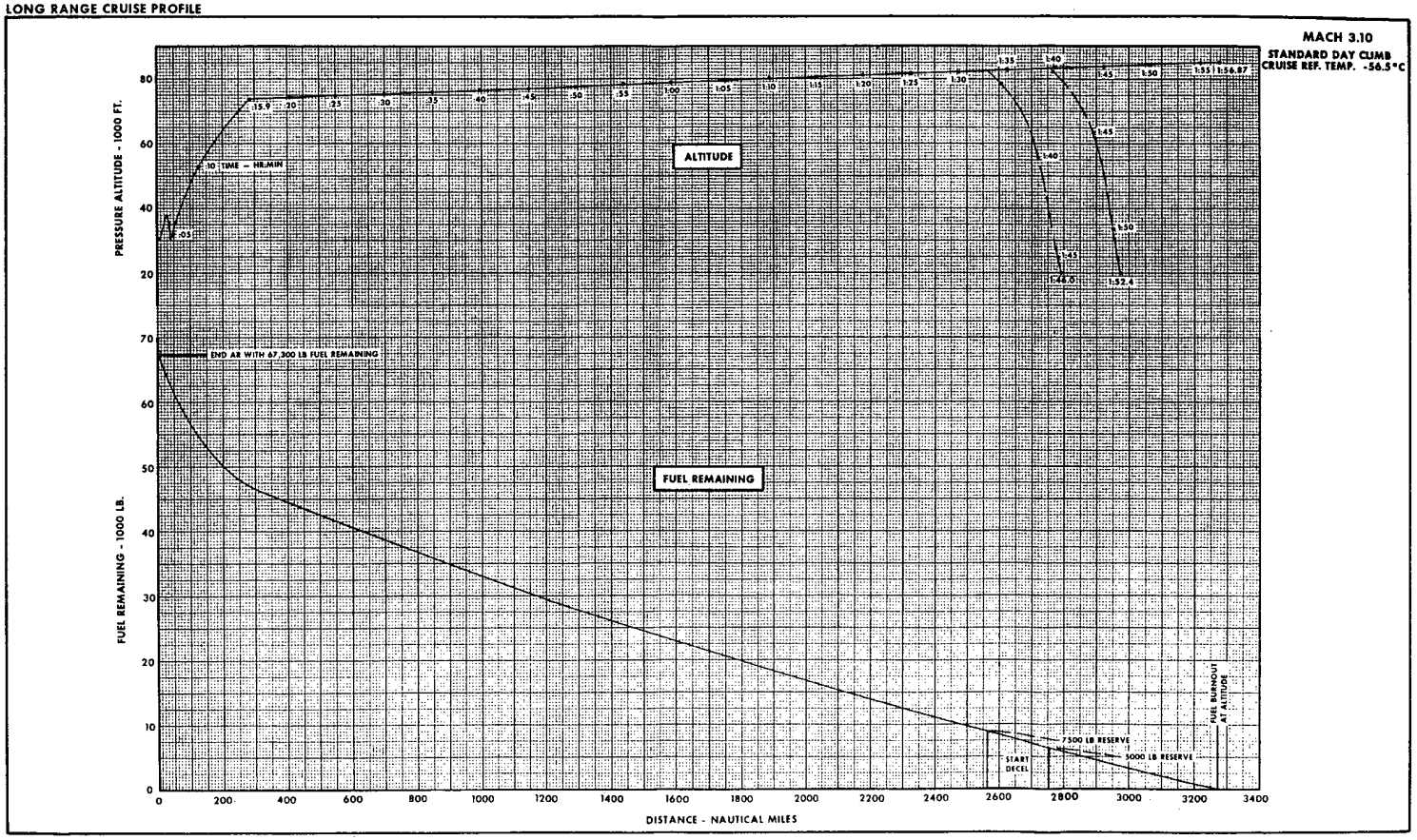
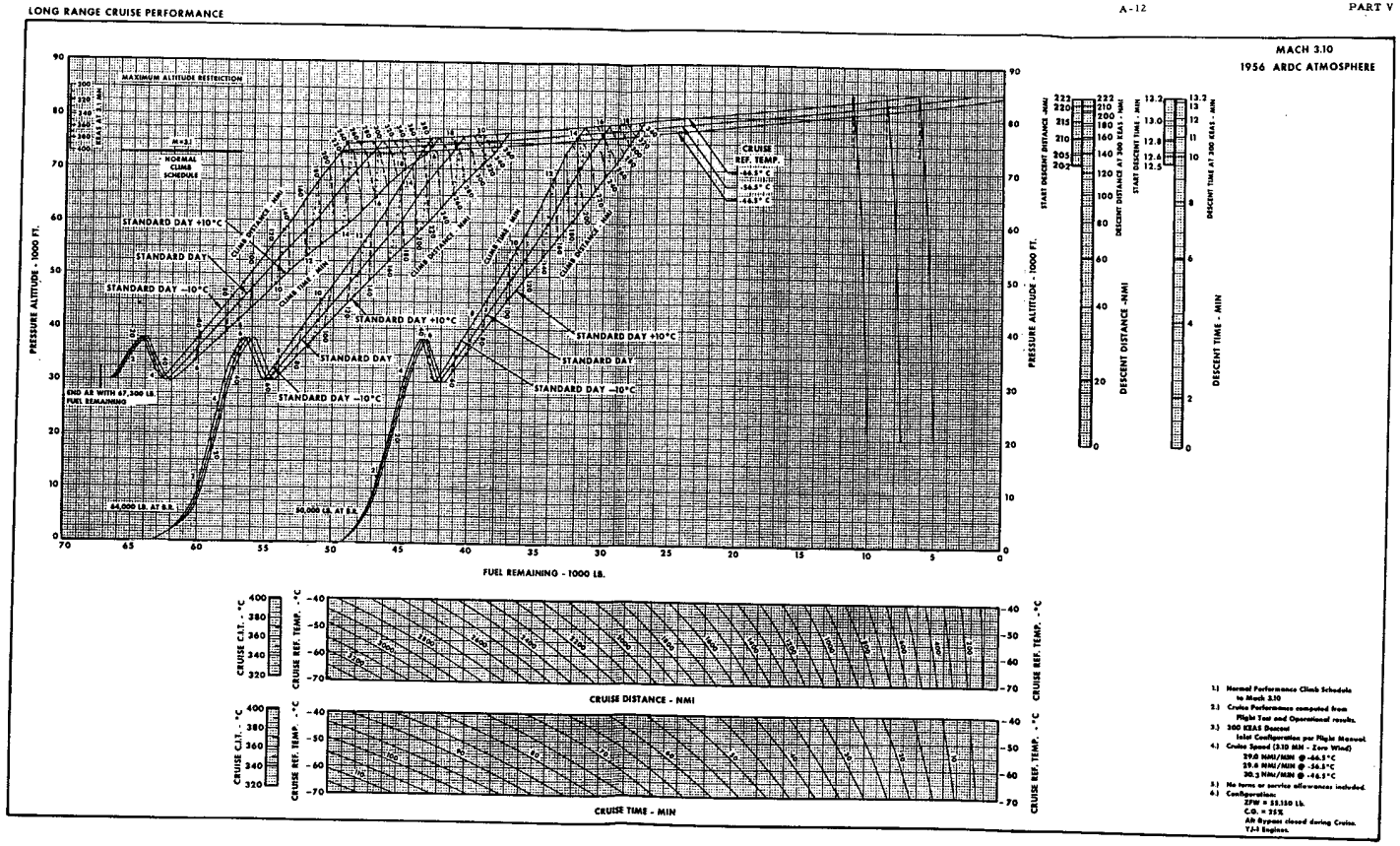


Figure A5-16
(Sheet 1 of 3)


MACH 3.10
1956 ARDC ATMOSPHERE
MAXIMUM ALTITUDE RESTRICTION
NORMAL CLIMB SCHEDULE
M=3.1
CRUISE REF. TEMP.
PRESSURE ALTITUDE - 1000 FT.
FUEL REMAINING - 1000 LB.
STANDARD DAY +10°C
STANDARD DAY
STANDARD DAY -10°C
END AR WITH 67,300 LB. FUEL REMAINING
64,000 LB. AT S.S.
50,000 LB. AT E.S.
START DESCENT DISTANCE - NMI
DESCENT DISTANCE AT 300 KEAS - NMI
DESCENT DISTANCE - NMI
START DESCENT TIME - MIN
DESCENT TIME AT 300 KEAS - MIN
DESCENT TIME - MIN
CRUISE C.I.T. - °C
CRUISE REF. TEMP. - °C
CRUISE DISTANCE - NMI
CRUISE TIME - MIN
1.) Normal Performance Climb Schedule to Mach 3.10
2.) Cruise Performance computed from Flight Test and Operational results.
3.) 300 KEAS Descent
Inlet Configuration per Flight Manual
4.) Cruise Speed (3.10 MN - Zero Wind)
29.0 NMI/MIN @ -66.5°C
29.8 NMI/MIN @ -56.5°C
30.3 NMI/MIN @ -46.5°C
5.) No turns or service allowances included.
6.) Configuration:
ZFW = 55,150 Lb.
C.G. = 25%
Alt Bypass closed during Cruise.
YJ-1 Engines.

Changed 15 June 1968

Figure A5-16
(Sheet 3 of 3)

HIGH ALTITUDE CRUISE PERFORMANCE

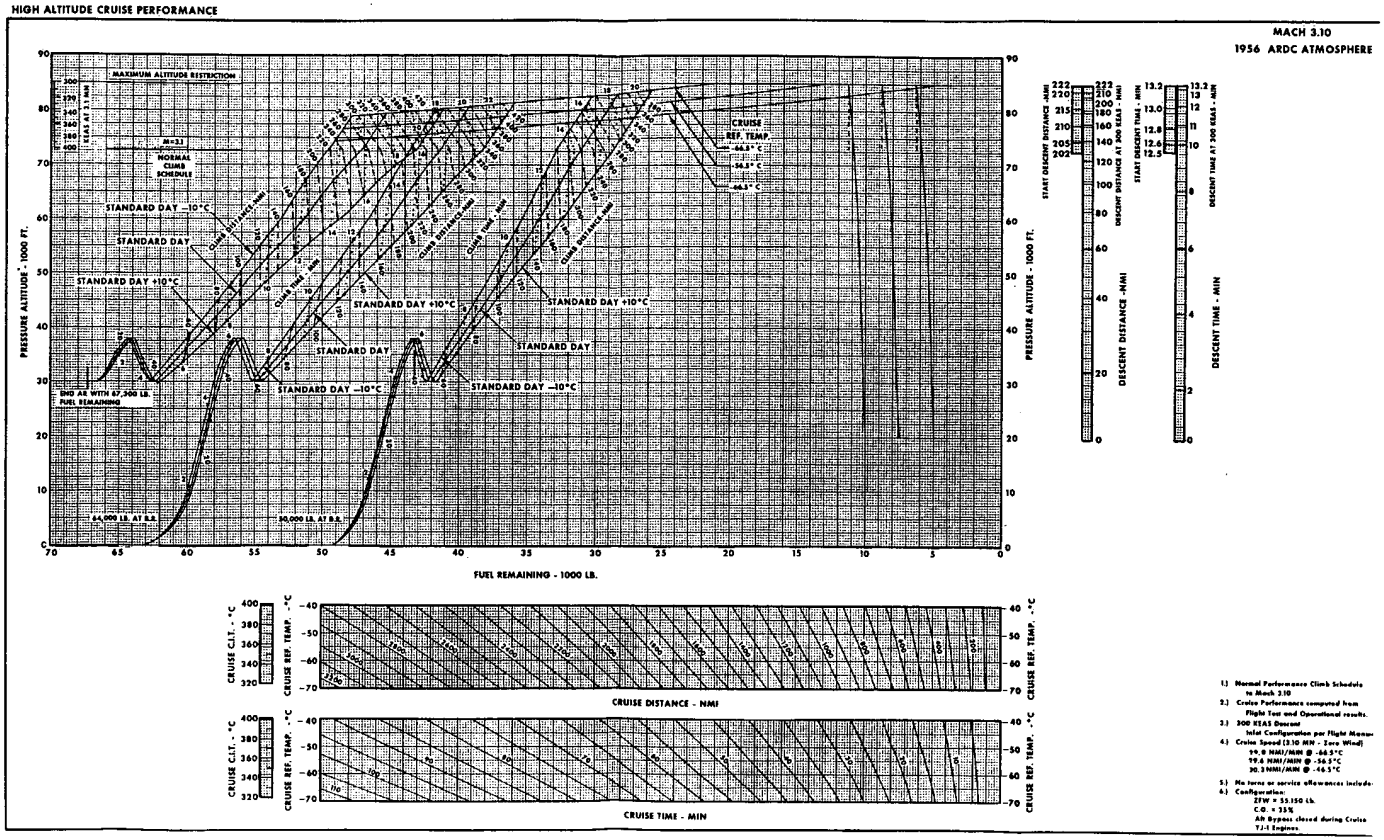

MACH 3.10
1956 ARDC ATMOSPHERE
MAXIMUM ALTITUDE RESTRICTION
NORMAL CLIMB SCHEDULE
STANDARD DAY -10°C
STANDARD DAY
STANDARD DAY +10°C
END AS WITH 67,500 LB. FUEL REMAINING
64,000 LB. AT S.L.
30,000 LB. AT S.L.
PRESSURE ALTITUDE - 1000 FT.
FUEL REMAINING - 1000 LB.
CRUISE REF. TEMP.
-44.5° C
-54.5° C
-66.5° C
START DESCENT DISTANCE -NMI
DESCENT DISTANCE AT 300 KEAS - NMI
DESCENT DISTANCE -NMI
START DESCENT TIME - MIN
DESCENT TIME AT 300 KEAS - MIN
DESCENT TIME - MIN
CRUISE C.I.T. - °C
CRUISE REF. TEMP. - °C
CRUISE DISTANCE - NMI
CRUISE TIME - MIN
1) Normal Performance Climb Schedule to Mach 3.10
2) Cruise Performance computed from Flight Test and Operational results.
3) 300 KEAS Descent Inlet Configuration per Flight Manual
4) Cruise Speed (3.10 MN - Zero Wind)
99.0 NMI/MIN @ -44.5°C
99.6 NMI/MIN @ -54.5°C
30.3 NMI/MIN @ -66.5°C
5) No turns or service allowances include.
6) Configuration:
ZFW = 55,150 Lb.
C.G. = 35%
All Bypass closed during Cruise
YJ-1 Engines.

Figure A5-17
(Sheet 3 of 3)

PART III

CLIMB AND DESCENT PERFORMANCE

List of Illustrations

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Phase II, Transonic Maneuver	A3-3
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Normal Climb Performance ("MEAN TROPIC" Atmosphere)	
Phase I, Subsonic climb from brake release	A3-7
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400 KEAS	A3-23B
Single Engine Turning Descent	A3-24

NORMAL CLIMB PERFORMANCE

Figures A3-1 through A3-12 present normal performance to cruise altitudes for supersonic operation with 1956 ARDC Atmosphere and "MEAN TROPIC" Atmospheric conditions, respectively. The data is computed from results of Flight Test and Operational Testing with YJ-1 engines. The climb is segmented in three phases and includes the effects of varying gross weights and air temperatures on fuel used, time, and distance. Phase I is the subsonic portion of the climb from brake release at sea level to 38,000 feet and 0.90 Mach. Corrections for time, fuel, and distance are listed in the chart for takeoffs from other field elevations. Phase IA is the subsonic portion of the climb from various refuel altitudes to 38,000 feet and 0.90 Mach. Phase II is the transonic acceleration portion of the climb from 38,000 feet and 0.90 Mach to 30,000 feet and 1.25 Mach utilizing the "dive through" technique. Phase III is the supersonic portion of the climb from 30,000 feet and 1.25 Mach to the altitude at which cruise Mach number is first attained. Phase IIIA is the constant Mach portion of the climb from the end of Phase III to the altitude for start of cruise. The following is a tabulation of the average results of flight tests for Phase IIIA.

Cruise Profile Scheduled	Avg. R/C FPM	Power	Avg. Total Fuel Flow Lb/Min.
Long Range	2500	Cruise	666 (20,000/ PPH/eng)
High Altitude	4000	Max AB	900 (27,000/ PPH/eng)

Example (1):

Obtain the time, distance, and fuel required from brake release for takeoff at a field elevation of 4500 feet to 3.10 Mach and 73,000 feet for a standard day. Fuel load at brake release is 64,000 lb after subtracting ground fuel allowances for normal ground operation. (See Appendix, Part II, for ground allowance computation procedure.) Find the initial gross weight at brake release by adding the zero fuel weight and the fuel load remaining. If the zero fuel weight is 55,150 pounds, the initial gross weight is 119,150 pounds.

Enter figure A3-1 at the initial gross weight at brake release and read fuel used, time and distance for Phase I as 7800 pounds, 6.47 minutes, and 48.6 nautical miles, respectively.

From the table in table in figure A3-1 for the 4500 foot field elevation, reduce time, fuel, and distance by 0.30 minutes, 500 pounds, and 1.6 nautical miles. Therefore, fuel used, time, and distance for Phase I are 7300 lb (7800-500), 6.17 min. (6.47-0.30), and 47.0 nmi (48.6 - 1.6). Recompute the gross weight at the end of Phase I climb as 111,850 pounds (119,150 - 7300). Enter figure A3-3 at the recomputed gross weight and read fuel used, time and distance for Phase II as 1420 pounds, 1.20 minutes and 12.2 nautical miles. Summation of Phase I and Phase II results in the fuel used, time, and distance to the start of Phase III as 8720 pounds (7300 + 1420), 7.37 minutes (6.17 + 1.20), and 59.2 nautical miles (47.0 + 12.2). The recomputed gross weight for entering Phase III will be 110,430 pounds (119,150 - 8720). Enter figure A3-5 with the recomputed gross weight and at 73,000 feet and Mach 3.10, read fuel used, time, and distance for Phase III as 13,500 pounds, 9.9 minutes, and 205.6 nautical miles, respectively. Add all three phases and obtain fuel used, time, and distance

PART III

CLIMB AND DESCENT PERFORMANCE

List of Illustrations

Title	Figure No.
RAPID DEPLOYMENT TO ARCP — SEE TDC #10 7 MAY 68	FRONT OF FLIGHT MANUAL
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Normal Climb Performance After Air Refueling (1956 ARDC Atmosphere)	A3-6
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Mean Tropic Day, Supersonic Climb	A3-10
Mean Tropic Day +10°C ΔT, Supersonic Climb	A3-11
Normal Climb Performance After Air Refueling ("MEAN TROPIC" Atmosphere)	A3-12
Military Thrust Climb Performance, Std Day -10°C ΔT	A3-13
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350 KEAS Descent Performance	A3-18
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- 350 KEAS	A3-22
- 400 KEAS	A3-23
Single Engine Turning Descent	A3-24

NORMAL CLIMB PERFORMANCE

FROM BRAKE RELEASE

Figures A3-1 through A3-5 and A3-7 through A3-11 present normal climb performance from brake release to cruise altitudes for supersonic operation with 1956 ARDC Atmosphere and "MEAN TROPIC" Atmospheric conditions, respectively. The data is computed from results of Flight Test and Operational Testing with YJ-1 engines. The climb is segmented in three phases and includes the effects of varying gross weights and air temperatures on fuel used, time, and distance. Phase I is the subsonic portion of the climb from brake release at sea level to 30,000 feet and 0.90 Mach. Cor-

rections for time, fuel, and distance are listed in the chart for takeoffs from other field elevations. Phase II is the transonic acceleration portion of the climb from 30,000 feet and 0.90 Mach to 30,000 feet and 1.25 Mach utilizing the climb and dive technique. Phase III is the supersonic portion of the climb from 30,000 feet and 1.25 Mach to the altitude at which cruise Mach number is first attained. Phase IIIA is the constant Mach portion of the climb from the end of Phase III to the altitude for start of cruise. The following is a tabulation of the average results of flight tests for Phase IIIA.

Cruise Profile Scheduled	Avg. R/C FPM	Power	Avg. Total Fuel Flow Lb/Min.
Long Range	2500	Cruise	666 (20,000/ PPH/eng)
High Altitude	4000	Max AB	900 (27,000/ PPH/eng)

Example:

Obtain the time, distance, and fuel required from brake release for takeoff at a field elevation of 4500 feet to 3.10 Mach and 73,000 feet for a standard day. Fuel load at brake release is 64,000 lb after subtracting ground fuel allowances for normal ground operation. (See Appendix, Part II, for ground allowance computation procedure.) Find the initial gross weight at brake release by adding the zero fuel weight and the fuel load remaining. If the zero fuel weight is 55,150 pounds, the initial gross weight is 119,150 pounds. Enter figure A3-1 at the initial gross weight at brake release and read fuel used, time and distance for Phase I as 6150 pounds, 4.8 minutes, and 34 nautical miles, respectively.

From the table in figure A3-1, for the 4500 foot field elevation, reduce time, fuel, and distance by 0.30 minutes, 500 lb, and 1.6 nmi, respectively. Therefore, fuel used, time, and distance for Phase I is 5650 lb (6150-500), 4.5 min. (4.8 - 0.3), and 32.4 nmi (34 - 1.6), respectively. Recompute the gross weight at end of climb Phase I as 113,500 pounds (119,150 - 5650). Enter figure A3-2 as the recomputed gross weight and read fuel used, time, and distance for Phase II as 3100 pounds, 2.9 minutes, and 27 nautical miles, respectively. Recompute the gross weight at end of Phase II as 110,400 pounds (113,500 - 3100). Enter figure A3-4 with the recomputed gross weight and at 73,000 feet and Mach 3.10, read fuel used, time, and distance for Phase III as 13,500 pounds, 9.9 minutes, and 205.6 nautical miles, respectively. Add all three phases and obtain fuel used, time, and distance as 22,250 pounds, 17.3 minutes, and 265 nautical miles, respectively. Fuel remaining at 73,000 feet is 41,750 pounds (64,000 - 22,250).

Service allowances and/or allowances for deviations from the normal climb schedule can be applied to an affected phase when required. (For example, a subsonic cruise operation prior to reaccelerating might be scheduled in the flight plan.) The effect of such an allowance must be accounted for when computing the initial weight to be used for the next phase of the climb.

AFTER AIR REFUELING

Figures A3-6 and A3-12 present normal climb performance from the end of 30,000 foot refuel (refueling with one AB on) to the altitudes at which cruise Mach number is reached for 1956 ARDC Atmosphere and "MEAN TROPIC" Atmospheric conditions, respectively. Adjustments which should be used for other end A/R altitudes are listed in the charts. The data is computed from Flight Test and Operational Testing results with YJ-1 engines. The assumed fuel load at the end of A/R is 67,300 lb. Phase IIIA results are identical to the tabulation in the previous discussion.

PHASE III CLIMB WITH TURNS

Turns during climb are not recommended, however, if mission requirements include a turn, compensation for range lost due to the turn must be included in the flight plan. For example, consider a 45° heading change with a 30° bank at an initial altitude of 45,000 feet.

To minimize the rate of climb loss due to turning, the recommended procedure is to advance power to Maximum A/B during the turn and maintain the speed schedule of 450 KEAS. Resume the normal climb procedure on completion of the turn.

Comparison of straightaway climb and turning climb on time, fuel and distance results in an overall range loss of 32 miles for a Mach 3.20 profile. On completion of the 45° turn, at 49,000 feet; time, fuel and distance to that altitude will be 0.35 min, 730 lb, and 6.4 mi greater than for a normal climb with no turn.

MILITARY THRUST CLIMB PERFORMANCE

Figures A3-13 thru A3-16 present Military climb performance for a schedule of 300 knots equivalent airspeed (KEAS) while below 33,300 feet and 0.90 Mach number when higher altitudes are attained. This power and speed schedule provides the most climb distance for the fuel consumed when subsonic cruising flight plans, such as for ferry or buddy missions, are used.

Example (1):

Find the time, distance and fuel required to climb to 30,000 feet from S. L. on a std -10°C day with an initial gross weight of 105,000 lb. Enter figure A3-13 at 30,000 ft, and at 105,000 lb initial gross weight read 8.5 min, 56.6 miles and 4200 lbs. Adding takeoff allowances results in time, distance and fuel values of 9.4 min. (8.5 + 0.9), 59.2 miles (56.6 + 2.6) and 6000 lb (4200 + 1800) for climb from sea level to 30,000 feet.

Example (2):

Find the time, distance and fuel required to climb to 30,000 feet from 4500 foot takeoff on a std day with an initial gross weight of 105,000 pounds. Enter figure A3-14 at 4500 feet and at 105,000 pound initial gross weight; read 0.4 min, 3.8 miles and 550 pounds. Reenter figure A3-14 at 30,000 feet and an adjusted initial gross weight of 105,550 pounds; read 8.6 min, 58.0 miles and 4300 pounds. Adding takeoff allowances and subtracting values for climb from sea level to 4500 feet results in time, distance and fuel values of 9.1 min (8.6 + .9 - .4), 56.8 miles (58.0 + 2.6 - 3.8) and 5550 pounds (4300 + 1800 - 550) for climb from takeoff at 4500 to 30,000 feet.

TWO ENGINE DESCENT PERFORMANCE

On course descent performance is shown on figures A3-17, A3-18, and A3-19. Figure A3-17 presents descent performance for the normal 300 KEAS schedule. Figures A3-18 and A3-19 present 350 KEAS descent performance with forward bypass doors in the automatic and open positions respectively.

SINGLE ENGINE DESCENT PERFORMANCE

Figures A3-20 through A3-24 present single engine descent performance from 80,000 feet and Mach 3.10 (337 KEAS). The data is based on flight test with the inlet configuration as listed in the charts. Time, distance, and fuel required are plotted versus altitude. A pushover at constant Mach is required to increase airspeed from 337 KEAS to the 350 KEAS or 400 KEAS schedule. Better range is obtained when the 300 KEAS schedule is used, reducing airspeed to 300 KEAS while maintaining constant altitude. These effects are in-

cluded in the performance data. Specific range begins to decrease rapidly near 50,000 feet; therefore, the charts are indexed to an altitude of 50,000 feet so that a power reduction technique can be used and the resultant change in performance can be determined. The effect of changing KEAS at the indexed 50,000 feet has not been defined by flight testing and is not included in the data.

Figure A3-20 summarizes the effect of airspeed on Maximum AB descent performance for constant values of 300, 350, and 400 KEAS. Figures A3-21 through A3-23 present the effects of decreasing power at the index altitude of 50,000 feet for constant airspeeds of 300, 350, and 400 KEAS, respectively. Figure A3-24 presents the effects of a 180° turn at 35° bank angle on a 350 KEAS descent. Approximately 23,000 feet of altitude is required to complete the 180° turn. For convenience in mission planning, a ground track profile is also provided.

Example (1):

Find the time, distance, and fuel required to descend on course from 80,000 feet and Mach 3.10 using the 300 KEAS descent schedule and Minimum AB below 50,000 feet. Enter figure A3-21 at 80,000 feet and read the time, distance, and fuel required to 50,000 feet as 8.6 minutes, 176 nautical miles, and 2800 pounds of fuel. Reenter at the final altitude of 31,500 feet on the Minimum AB line and read time, distance, and fuel required as 5 minutes, 52 nautical miles and 1600 lb of fuel. Add the results and obtain 13.6 minutes, 228 nautical miles, and 4400 pounds of fuel.

Example (2):

Find the track time, distance, and fuel required to descend from 80,000 feet and Mach 3.10 using the 350 KEAS descent schedule. A 90° turn is to be completed above 50,000 feet, and Minimum AB is to be used below 50,000 feet. Enter figure A3-24 and note on the penetration distance curve that 90° of turn is completed at 65,000 feet altitude. Read time at that altitude as 3.0 minutes and fuel used as 1200 pounds. On the ground track profile note that the distance traveled is 80 nautical miles. Enter figure A3-22 at 65,000 feet (end of turn altitude) and read time, distance, and fuel required to 50,000 feet as 4.1 minutes, 73 nautical miles, and 1950 pounds. Reenter at the final altitude of 28,000 feet on the Minimum AB line and read time, distance, and fuel required as 3.4 minutes, 41 nautical miles and 1200 lb of fuel. Add the incremental readings and obtain 10.5 minutes, 194 nautical miles, and 4350 pounds of fuel.

as 22,200 pounds, 17.3 minutes, and 265 nautical miles, respectively. Fuel remaining at 73,000 feet is 41,800 pounds (64,000 - 22,200).

Service allowances and/or allowances for deviations from the normal climb schedule can be applied to an affected phase when required. (For example, a subsonic cruise operation prior to reaccelerating might be schedule in the flight plan.) The effect of such an allowance must be accounted for when computing the initial weight to be used for the next phase of the climb.

Example (2):

Obtain the MEAN TROPIC day time, distance, and fuel required from refuel at 29,000 feet to 0.90 Mach at 38,000 feet (start of Phase II). Enter fig. A3-8 at 29,000 feet and read fuel used, time, and distance for Phase IA as 3740 pounds, 3.60 minutes, and 31.6 nautical miles, respectively. The recomputed gross weight for entering Phase II will be 118,710 pounds (122,450 - 3740).

PHASE III CLIMB WITH TURNS

Turns during climb are not recommended, however, if mission requirements include a turn, compensation for range lost due to the turn must be included in the flight plan. For example, consider a 45° heading change with a 30° bank at an initial altitude of 45,000 feet.

To minimize the rate of climb loss due to turning, the recommended procedure is to advance power to Maximum A/B during the turn and maintain the speed schedule of 450 KEAS. Resume the normal climb procedure on completion of the turn.

Comparison of straightaway climb and turning climb on time, fuel and distance results in an overall range loss of 32 miles for a Mach 3.20 profile. On completion of the 45° turn, at 49,000 feet; time, fuel and distance to that altitude will be 0.35 min, 730 lb, and 6.4 mi greater than for a normal climb with no turn.

MILITARY THRUST CLIMB PERFORMANCE

Figures A3-13 thru A3-16 present Military climb performance for a schedule of 300 knots equivalent airspeed (KEAS) while below 33,300 feet and 0.90 Mach number when higher altitudes are attained. This power and speed schedule provides the most climb distance for the fuel consumed when subsonic cruising flight plans, such as for ferry or buddy missions, are used.

Example (1):

Find the time, distance and fuel required to climb to 30,000 feet from S. L. on a std -10°C day with an initial gross weight of 105,000 lb. Enter figure A3-13 at 30,000 ft, and at 105,000 lb initial gross weight read 8.5 min, 56.6 miles and 4200 lbs. Adding takeoff allowances results in time, distance and fuel values of 9.4 min. (8.5 + 0.9), 59.2 miles (56.6 + 2.6) and 6000 lb (4200 + 1800) for climb from sea level to 30,000 feet.

Example (2):

Find the time, distance and fuel required to climb to 30,000 feet from 4500 foot takeoff on a std day with an initial gross weight of 105,000 pounds. Enter figure A3-14 at 4500 feet and at 105,000 pound initial gross weight; read 0.4 min, 3.8 miles and 550 pounds. Reenter figure A3-14 at 30,000 feet and an adjusted initial gross weight of 105,550 pounds; read 8.6 min, 58.0 miles and 4300 pounds. Adding takeoff allowances and subtracting values for climb from sea level to 4500 feet results in time, distance and fuel values of 9.1 min (8.6 + .9 - .4), 56.8 miles (58.0 + 2.6 - 3.8) and 5550 pounds (4300 + 1800 - 550) for climb from takeoff at 4500 to 30,000 feet.

TWO ENGINE DESCENT PERFORMANCE

On course descent performance is shown on figures A3-17, A3-18, and A3-19. Figure A3-17 presents descent performance for the normal 300 KEAS schedule. Figures A3-18 and A3-19 present 350 KEAS descent performance with forward bypass doors in the automatic and open positions respectively.

SINGLE ENGINE DESCENT PERFORMANCE

Single Engine Descent data is presented for Military, Minimum afterburning and Maximum afterburning power at 300, 350 and 400 KEAS with 1956 ARDC and Mean Tropic Atmosphere conditions. Refer to figures A3-20 through A3-23B.

Allowances For Deceleration To Descent Speed:

When cruising at a higher KEAS than the desired descent schedule, the constant altitude deceleration is made at the same power setting as the constant KEAS descent. The constant Mach lines show the beginning point of the deceleration for each Mach number. In the situation where the cruise KEAS is less than the desired descent KEAS, the constant Mach descent is made with Maximum afterburning power. The constant Mach lines show the descent for different Mach numbers.

Comparison Of Descent Power and Speed Schedules:

The Maximum afterburning descent, as compared to the Minimum afterburning and Military power descents, results in a longer distance, a longer elapsed time and more fuel used. The 400 KEAS descent as compared to the 350 and 300 KEAS descents results in a slightly longer distance, less elapsed time and more fuel used. Maximum overall range results if a descent speed of 300 KEAS is used and if Military power is used in the descent and for cruise. There will be little overall range loss if either Minimum afterburning or Maximum afterburning descent power is used as long as the cruise is accomplished in Military power. The charts are indexed to an altitude of 50,000 feet so that a technique of power or airspeed change can be used and the resultant effect after power change in performance can be determined. The effect of changing KEAS at the indexed 50,000 feet has not been defined by flight testing and is not included in the data.

CAUTION

When making a single engine descent with the operating engine in Military power, the Mach rate limit of 1.0 Mach in three minutes will be exceeded.

Single Engine Turning Descent

Figure A3-24 presents the effects of a 180° turn at 35° bank angle on a 350 KEAS descent. Approximately 23,000 feet of altitude is required to complete the 180° turn. For convenience in mission planning, a ground track profile is also provided.

Sample Use Of Charts

Example (1):

Find distance, time and fuel to descend from 80,000 feet to 29,000 feet, using Minimum afterburning power and 300 KEAS. Initial speed is Mach 3.1 (337 KEAS). Normal (ARDC Standard) atmosphere conditions are expected. Refer to Figure A3-20. Enter the chart at 80,000 feet and located the Minimum afterburning line for the 3.1 Mach, (337 KEAS) condition, and read distance, time and fuel to 50,000 feet.

Distance = 137 miles

Time = 6.8 minutes

Fuel = 1200 pounds

Enter the same chart at 29,000 feet and read distance, time and fuel from 50,000 feet to 29,000 feet.

Distance = 75 miles

Time = 8.5 minutes

Fuel = 2400 pounds

Add the above values to obtain distance time and fuel from 80,000 feet and 3.1 Mach to 29,000 feet in Minimum afterburning at 300 KEAS.

Distance = 212 miles

Time = 15.3 minutes

Fuel = 3600 pounds

Example (2):

Find the track time, distance, and fuel required to descend from 80,000 feet and Mach 3.10 using the 350 KEAS descent schedule. A 90° turn is to be completed above 50,000 feet, and Minimum AB is to be used below 50,000 feet. Enter figure A3-24 and note on the penetration distance curve that 90° of turn is completed at 65,000 feet altitude. Read time at that altitude as 3.0 minutes and fuel used as 1200 pounds. On the ground track profile note that the distance traveled is 80 nautical miles. Enter figure A3-21 at 65,000 feet (end of turn altitude) and read time, distance, and fuel required to 50,000 feet as 4.1 minutes, 73 nautical miles, and 1950 pounds. Reenter at the final altitude of 28,000 feet on the Minimum AB line and read time, distance, and fuel required as 3.4 minutes, 41 nautical miles and 1200 lb of fuel. Add the incremental readings and obtain 10.5 minutes, 194 nautical miles, and 4350 pounds of fuel.

MAXIMUM A/B CEILING CRUISE PROFILE

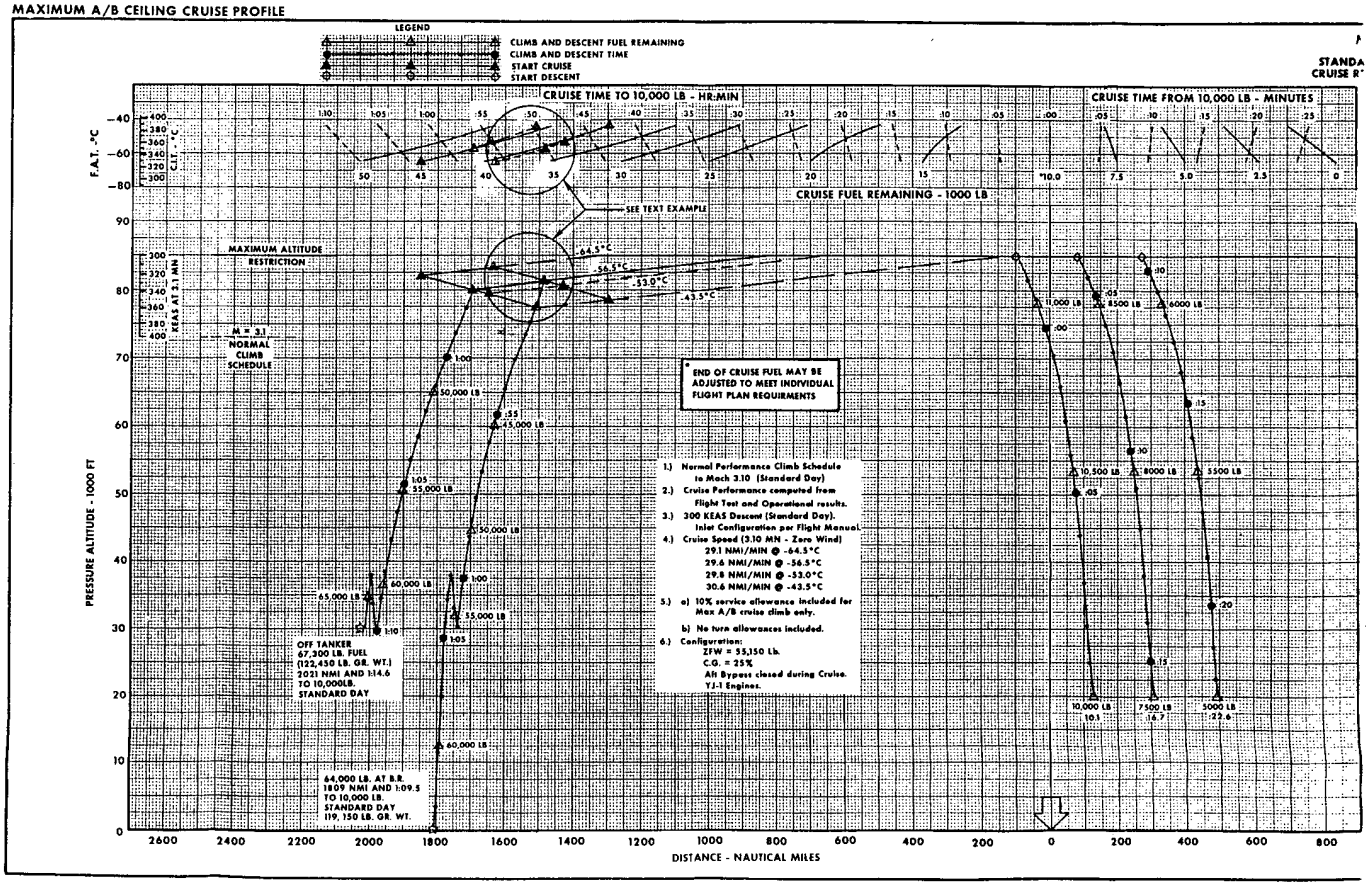

LEGEND
CLIMB AND DESCENT FUEL REMAINING
CLIMB AND DESCENT TIME
START CRUISE
START DESCENT
CRUISE TIME TO 10,000 LB - HR:MIN
CRUISE TIME FROM 10,000 LB - MINUTES
CRUISE FUEL REMAINING - 1000 LB
F.A.T. °C
C.I.T. °C
KEAS AT 3.1 MN
SEE TEXT EXAMPLE
MAXIMUM ALTITUDE RESTRICTION
M = 3.1 NORMAL CLIMB SCHEDULE
-64.5°C
-56.5°C
-53.0°C
-43.5°C
* END OF CRUISE FUEL MAY BE ADJUSTED TO MEET INDIVIDUAL FLIGHT PLAN REQUIREMENTS
1.) Normal Performance Climb Schedule to Mach 3.10 (Standard Day)
2.) Cruise Performance computed from Flight Test and Operational results.
3.) 300 KEAS Descent (Standard Day). Inlet Configuration per Flight Manual.
4.) Cruise Speed (3.10 MN - Zero Wind)
29.1 NMI/MIN @ -64.5°C
29.6 NMI/MIN @ -56.5°C
29.8 NMI/MIN @ -53.0°C
30.6 NMI/MIN @ -43.5°C
5.) a) 10% service allowance included for Max A/B cruise climb only.
b) No turn allowances included.
6.) Configuration:
ZFW = 55,150 Lb.
C.G. = 25%
Alt Bypass closed during Cruise.
YJ-1 Engines.
OFF TANKER
67,300 LB. FUEL
(122,450 LB. GR. WT.)
1021 NMI AND 1:14.6
TO 10,000LB.
STANDARD DAY
64,000 LB. AT S.R.
1809 NMI AND 1:09.5
TO 10,000 LB.
STANDARD DAY
119, 150 LB. GR. WT.
PRESSURE ALTITUDE - 1000 FT
DISTANCE - NAUTICAL MILES

Figure A5-18

(Sheet 2 of 2)

LONG RANGE CRUISE PROFILE

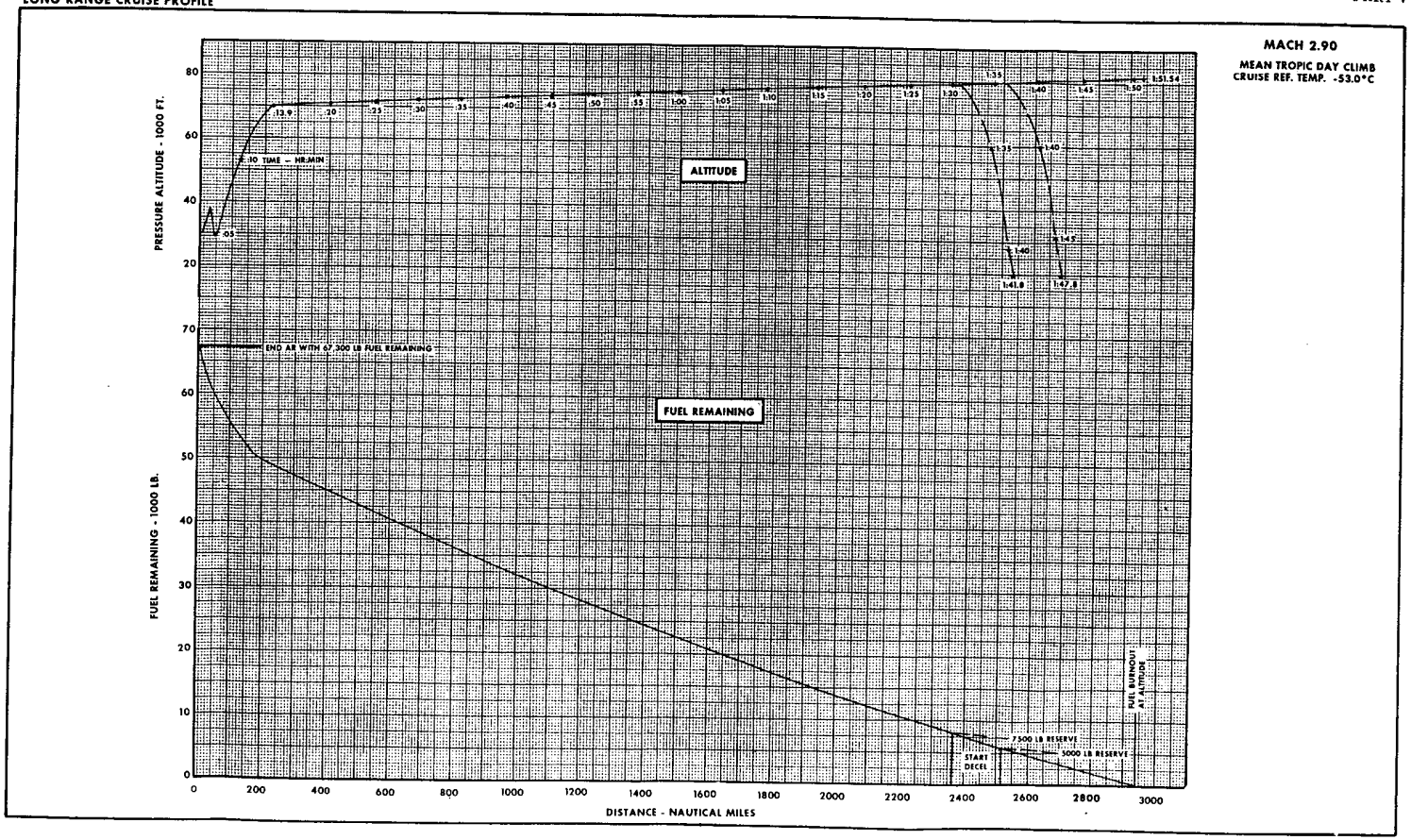
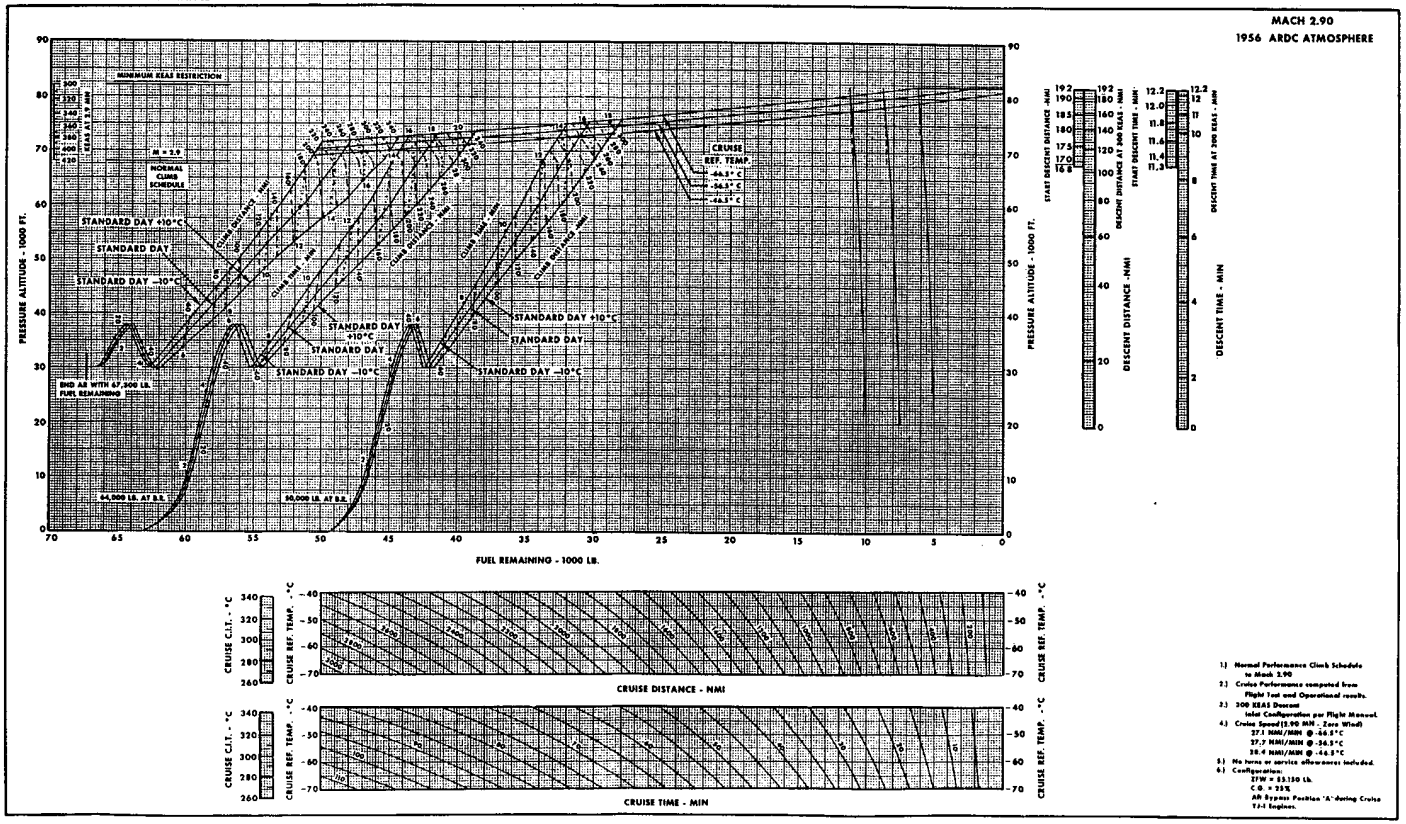


Figure A5-27

(Sheet 1 of 3)

LONG RANGE CRUISE PERFORMANCE


MACH 2.90
1956 ARDC ATMOSPHERE
PRESSURE ALTITUDE - 1000 FT.
FUEL REMAINING - 1000 LB.
MINIMUM KEAS RESTRICTION
NORMAL CLIMB SCHEDULE
STANDARD DAY +10°C
STANDARD DAY
STANDARD DAY -10°C
CRUISE REF. TEMP.
64,000 LB. AT S.R.
50,000 LB. AT S.R.
SAME AS WITH 67,500 LB. FUEL REMAINING
START DESCENT DISTANCE - NMI
DESCENT DISTANCE - NMI
START DESCENT TIME - MIN
DESCENT TIME - MIN
DESCENT TIME AT 300 KEAS - MIN
CRUISE C.I.T. - °C
CRUISE REF. TEMP. - °C
CRUISE DISTANCE - NMI
CRUISE TIME - MIN

1) Normal Performance Climb Schedule to Mach 2.90
2) Cruise Performance computed from Flight Test and Operational results.
3) 300 KEAS Descent Idle Configuration per Flight Manual.
4) Cruise Speed (2.90 MN - Zero Wind)
   37.1 NMI/MIN @ -66.8°C
   37.7 NMI/MIN @ -56.5°C
   38.4 NMI/MIN @ -46.8°C
5) No turns or service allowances included.
6) Configuration:
   TOW = 53,150 Lb.
   C.G. = 25%
   Alt Bypass Position 'A' during Cruise
   TJ-1 Engines.

Figure A5-26
(Sheet 3 of 3)

LONG RANGE CRUISE PROFILE

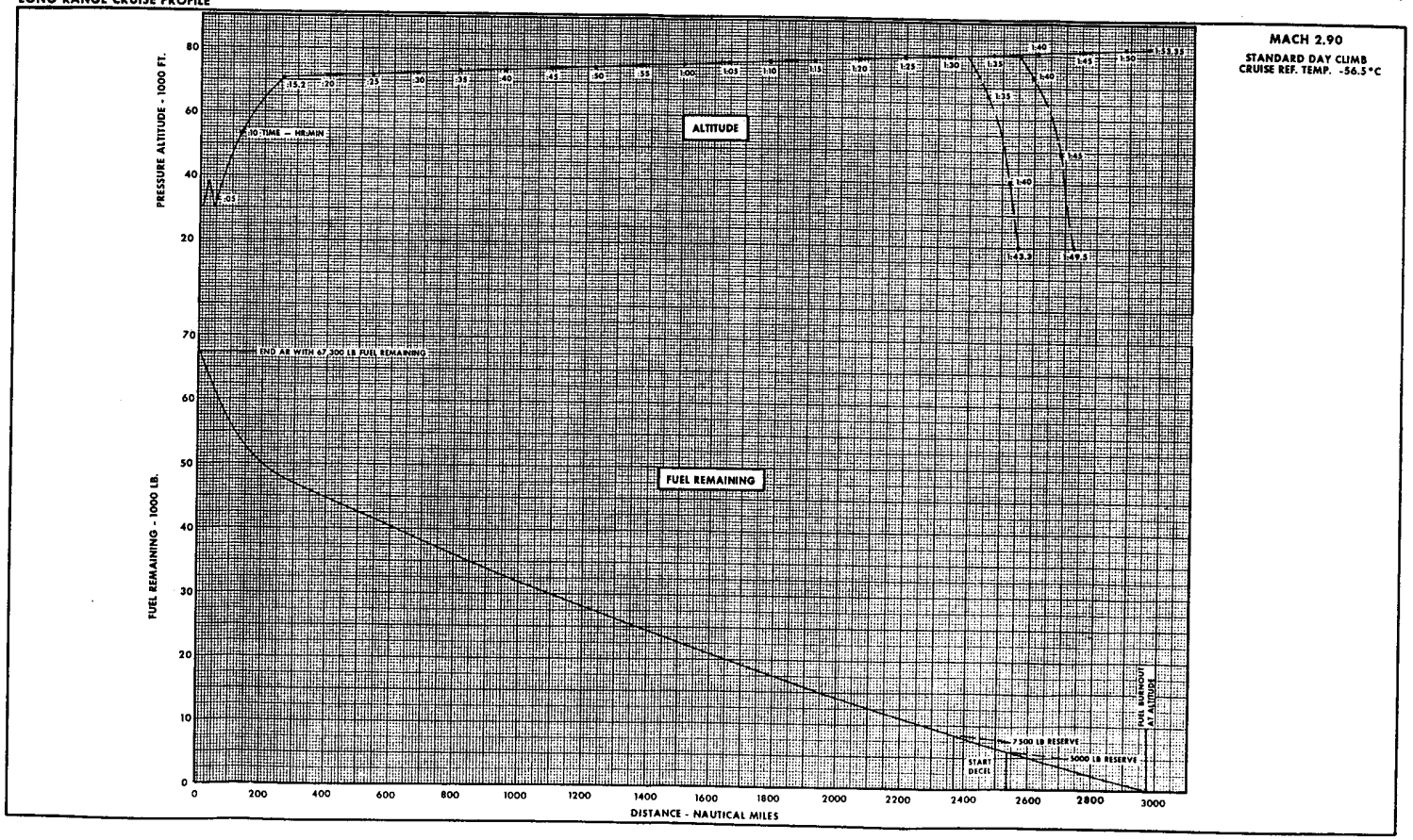


Figure A5-26

(Sheet 1 of 3)

HIGH ALTITUDE CRUISE PERFORMANCE

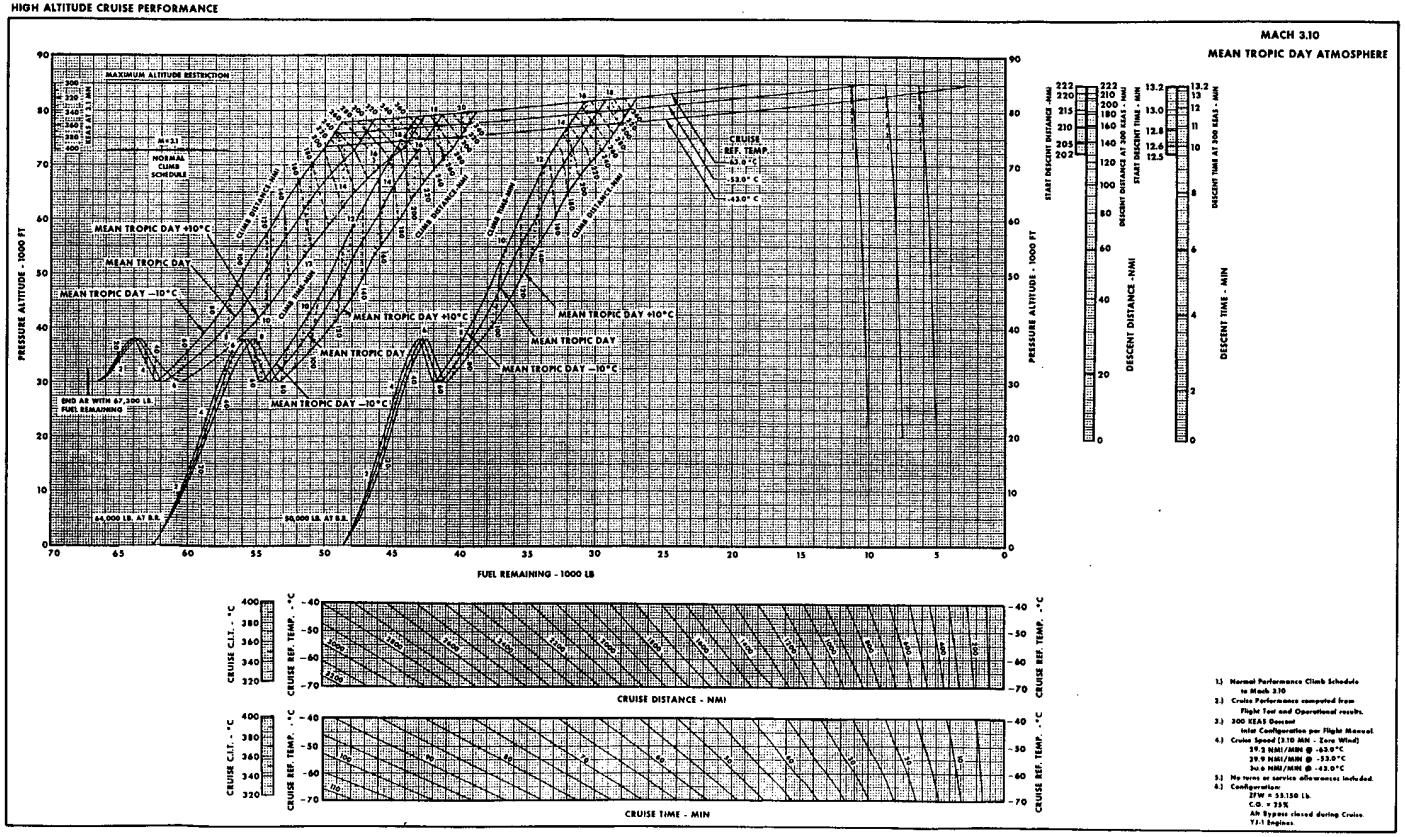

MACH 3.10
MEAN TROPIC DAY ATMOSPHERE
MAXIMUM ALTITUDE RESTRICTION
NORMAL CLIMB SCHEDULE
MEAN TROPIC DAY +10°C
MEAN TROPIC DAY
MEAN TROPIC DAY -10°C
CRUISE REF. TEMP.
-33.0° C
-53.0° C
-43.0° C
PRESSURE ALTITUDE - 1000 FT
FUEL REMAINING - 1000 LB
START DESCENT DISTANCE -NMI
DESCENT DISTANCE -NMI
START DESCENT TIME - MIN
DESCENT TIME - MIN
DESCENT DISTANCE AT 300 KEAS - NMI
DESCENT TIME AT 300 KEAS - MIN
CRUISE C.I.T. - °C
CRUISE REF. TEMP. - °C
CRUISE DISTANCE - NMI
CRUISE TIME - MIN
1.) Normal Performance Climb Schedule to Mach 3.10
2.) Cruise Performance computed from Flight Test and Operational results.
3.) 300 KEAS Descent Inlet Configuration per Flight Manual.
4.) Cruise Speed (3.10 MN - Zero Wind)
39.2 NMI/MIN @ -63.0°C
39.9 NMI/MIN @ -53.0°C
Jet A NMI/MIN @ -42.0°C
5.) No turns or service allowances included.
6.) Configuration:
ZFW = 55,150 Lb.
C.G. = 75%
Alt Bypass closed during Cruise.
YJ-1 Engines.

Figure A5-20
(Sheet 3 of 3)

HIGH ALTITUDE CRUISE PROFILE

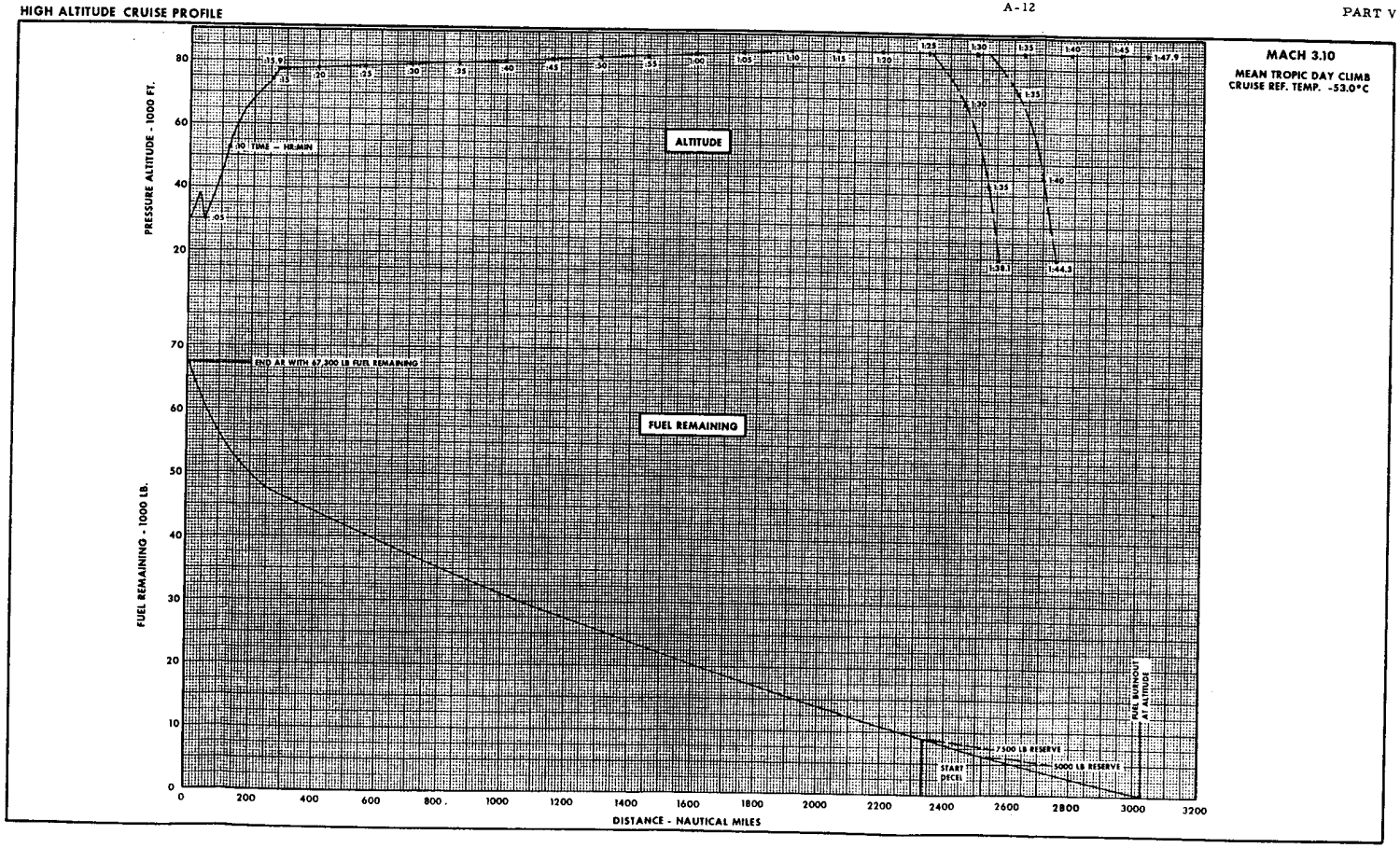


Figure A5-20

(Sheet 1 of 3)

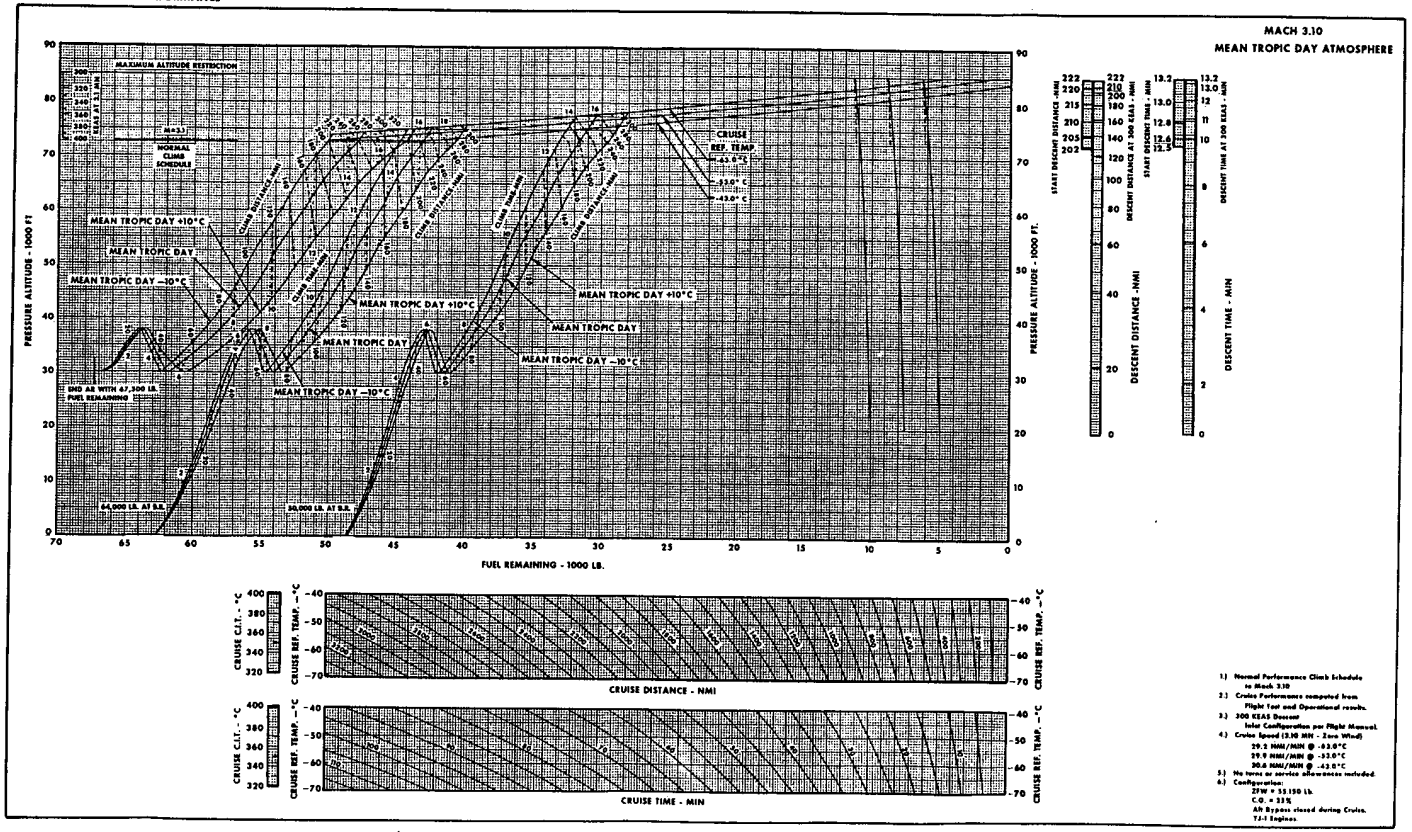

MACH 3.10
MEAN TROPIC DAY ATMOSPHERE
MAXIMUM ALTITUDE RESTRICTION
NORMAL CLIMB SCHEDULE
MEAN TROPIC DAY +10°C
MEAN TROPIC DAY
MEAN TROPIC DAY –10°C
CRUISE REF. TEMP.
PRESSURE ALTITUDE - 1000 FT.
FUEL REMAINING - 1000 LB.
START DESCENT DISTANCE -NMI
DESCENT DISTANCE AT 300 KEAS - NMI
DESCENT DISTANCE -NMI
START DESCENT TIME - MIN
DESCENT TIME AT 300 KEAS - MIN
DESCENT TIME - MIN
CRUISE C.I.T. - °C
CRUISE REF. TEMP. - °C
CRUISE DISTANCE - NMI
CRUISE TIME - MIN
1) Normal Performance Climb Schedule to Mach 3.10
2) Cruise Performance computed from Flight Test and Operational results.
3) 300 KEAS Descent Inlet Configuration per Flight Manual.
4) Cruise Speed (3.10 MN - Zero Wind)
29.3 NMI/MIN @ -53.0°C
29.9 NMI/MIN @ -53.0°C
30.6 NMI/MIN @ -43.0°C
5) No turns or service allowances included.
6) Configuration:
ZFW = 55,150 Lb.
C.G. = 33%
Aft Bypass closed during Cruise.
YJ-1 Engines

Figure A5-19
(Sheet 3 of 3)

LONG RANGE CRUISE PROFILE

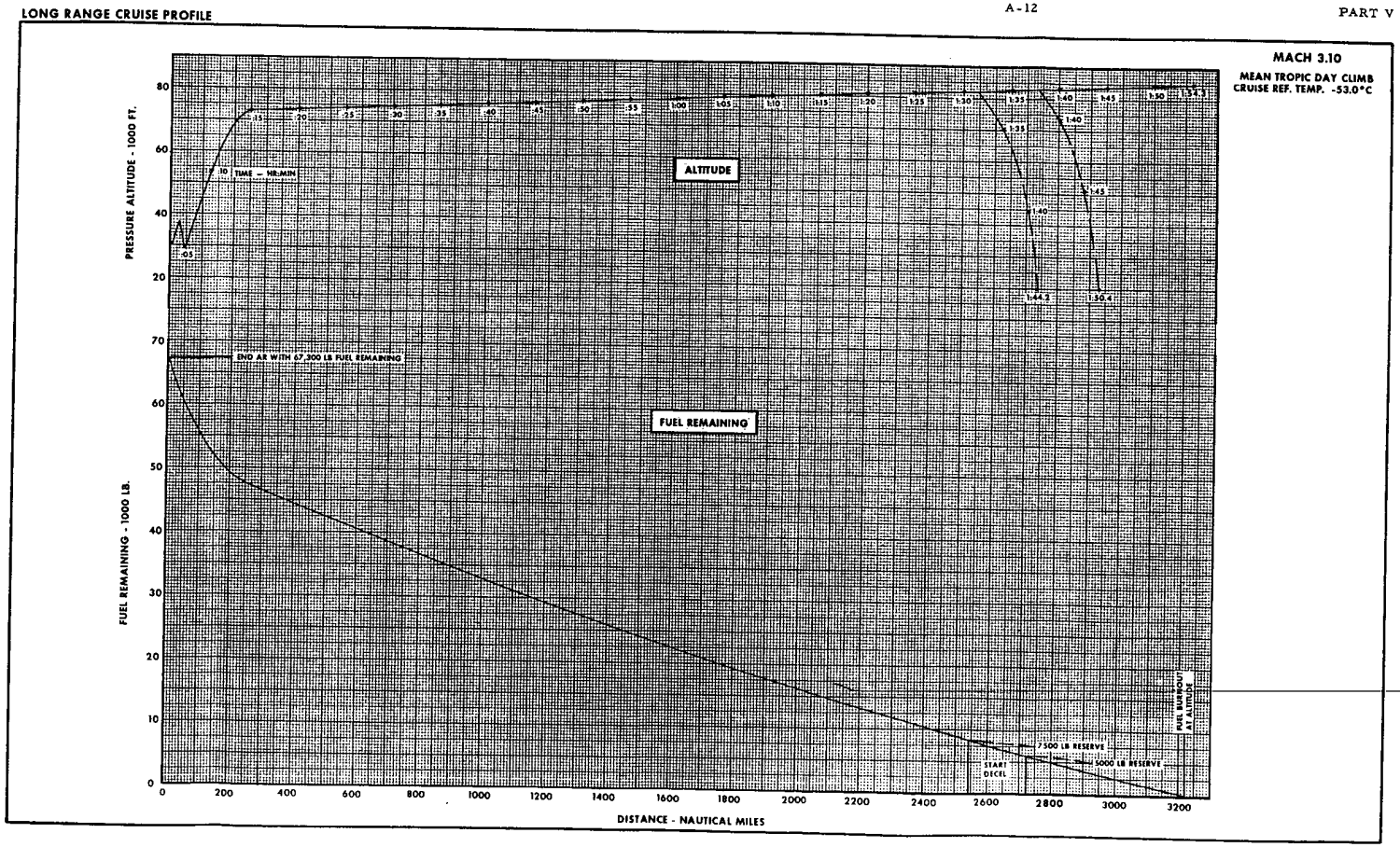


Figure A5-19

(Sheet 1 of 3)

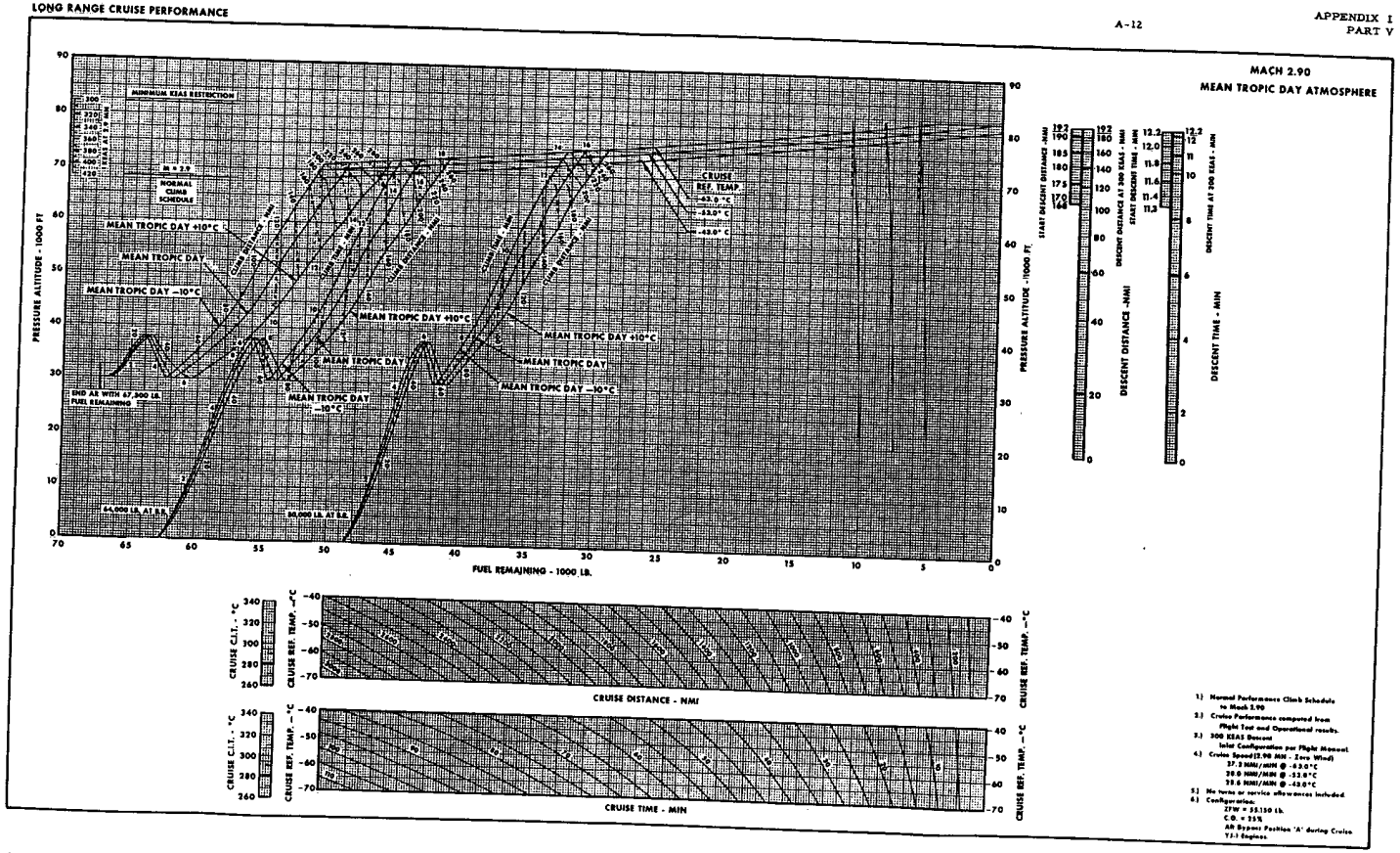

MACH 2.90
MEAN TROPIC DAY ATMOSPHERE
PRESSURE ALTITUDE - 1000 FT
FUEL REMAINING - 1000 LB.
MINIMUM KEAS RESTRICTION
M = 2.9
NORMAL CLIMB SCHEDULE
MEAN TROPIC DAY +10°C
MEAN TROPIC DAY
MEAN TROPIC DAY -10°C
END AR WITH 67,300 LB. FUEL REMAINING
64,000 LB. AT E.R.
50,000 LB. AT E.R.
CRUISE REF. TEMP.
-53.0 °C
-33.0 °C
+33.0 °C
START DESCENT DISTANCE - NMI
DESCENT DISTANCE AT 300 KEAS - NMI
DESCENT DISTANCE - NMI
START DESCENT TIME - MIN
DESCENT TIME AT 300 KEAS - MIN
DESCENT TIME - MIN
CRUISE C.I.T. - °C
CRUISE REF. TEMP. - °C
CRUISE DISTANCE - NMI
CRUISE TIME - MIN
1) Normal Performance Climb Schedule to Mach 2.90
2.) Cruise Performance computed from Flight Test and Operational results.
3.) 300 KEAS Descent Initial Configuration per Flight Manual.
4.) Cruise Speed (2.90 MN - Zero Wind)
37.3 NMI/MIN @ -53.0°C
38.0 NMI/MIN @ -33.0°C
38.6 NMI/MIN @ -13.0°C
5) No turns or service allowances included.
6) Configuration:
ZFW = 55150 Lb.
C.G. = 25%
Aft Bypass Position 'A' during Cruise.
TJ-3 Engines.

Figure A5-27
(Sheet 3 of 3)